An instrument to assess information systems succes in developing countries

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Publisher: University of Groningen
Groningen, The Netherlands

Printed by: Ipskamp Drukkers B.V.
Enschede, The Netherlands

ISBN: 978-90-367-5678-5 (Book)
978-90-367-5677-8 (Electronic Version)

RIJKSUNIVERSITEIT GRONINGEN

AN INSTRUMENT TO ASSESS INFORMATION SYSTEMS SUCCESS IN DEVELOPING COUNTRIES

Proefschrift

ter verkrijging van het doctoraat in de
Economie en Bedrijfskunde
aan de Rijksuniversiteit Groningen
op gezag van de
Rector Magnificus, dr. E. Sterken,
in het openbaar te verdedigen op
donderdag 25 oktober 2012
om 12.45 uur

door

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geboren op 27 september 1957
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Preface

Successful information systems are highly desirable especially in developing countries where funds for investment and development are scarce. There are documented outright failures of information systems of up to 30 percent in developing countries. The situation is exacerbated by a shortage of skilled and knowledgeable personnel, coupled with inadequate pay to keep them at their job. The contextual factors affecting developing countries are also different from developed countries, calling for a different approach from that used in developed countries. This study identified issues that, if addressed, can help in improving the prospects of achieving successful IS projects in developing countries. A computer-based instrument, as well as guidelines for assessing IS success was developed and evaluated. The instrument will enable managers and users of IS to collaborate in assessing an IS of their choice that will help them in avoiding failures of their IS.

I wish to acknowledge my indebtedness to my supervisors Prof. Dr. Henk G. Sol and Dr. Josephine Nabukenya Mukalazi, whose supervision and guidance has enabled me to produce this work.
My thanks also go to Prof. Dr. V. Barya Baryamureeba, whose constant help and encouragement has helped see me through the most hard times; Dr. Jude Lubega, who recommended that I be sent to study in the Netherlands; the Principal, College of Computing and Information Sciences and his deputy, as well as staff of the College of Computing and Information Sciences that helped create an enabling environment that made it possible for me to complete this work; my colleagues, Rev. Fr. Balinnya, Higenyi, Mubangizi, Doreen, Teddy, Raphael, Nakibuule, Agaba, Mercy, Annabella, Emmanuel, Wadembere and Dr. Maiga. Of special mention is Dr. Agnes Rwashana Semwanga who helped with System Dynamics modeling. Thanks also go to Gonny and Erik of the International Office. I have got a lot of help and encouragement from the general office staff especially Durkje Elzinga and Irene Ravenhorst, please thank you very much. I cannot forget the people who encouraged me to take up University education, prominent among them being Prof. Dr. Waswa Balunywa and Mr. Semukono of Makerere University Business School; I am very grateful.

Paul Ssemaluulu.

This work is dedicated to:

- My dearest wife Rose, my brothers Father Dr. Ssemusu, Sseruwagi, Kasirye; my sister Nnaggita and my in laws Felix Ssemujju, Eva and Charles Ssekyeewa, Louise and Richard Sseggwaanyi.
- My children who have been very understanding.

Contents

1. Information Systems Success

1.1 Introduction

Information systems (IS), can be viewed as socio-technical systems (Carlsson, 2007). IS are immersed as part of the business environment and cannot be separated from work-processes and the systemic properties of intra- and inter-organizational processes (Winter, 2008). In the world today, information systems are of utmost importance in the operation of national, private and public organizations. Information systems process and distribute information among different people in the organization. These are designed with the purpose of establishing a productive interaction between the system and its users in order to increase the effectiveness and efficiency of people performing their duties. Entire sectors of the economy are nearly inconceivable without substantial investments in information systems (Laudon and Laudon, 2007).

In developing countries, legacy information systems are gradually being replaced by modern systems with more sophisticated software and hardware applications (World Bank, 2010). These developments have forced organizations to re-evaluate and re-assess their information systems effectiveness.

Laudon and Laudon (2007) define information systems as *a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization.* In addition to support decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects and create new products. Information systems contain information about significant people, places, and things within the organization or in the environment surrounding it.

The success of information systems is an ambiguous, multi-faceted phenomenon that can be addressed with various measures. In practice, there are nearly as many measures as there are studies (Alaranta, 2005). IS success studies have attracted much attention in the last two decades as IS are widely being utilized at various levels (Petter *et al.,* 2008; Delone and McLean, 2002; DeLone and McLean, 1992). The popularity of IS success studies can be attributed to two main factors: firstly, the growing appreciation of the vital role of IS in organizations and the understanding of the issues involved in the assessment of the

effectiveness of IS; secondly, the dependency of organizations upon IS.

IS success can be defined as *the extent to which a system, given certain resources and means, achieves the goals for which it was designed.* In other words, IS success should be evaluated according to the degree to which the original objectives of a system are accomplished within the available resources (Kelegai, 2005). Seddon (1997) concludes that IS success is conceptualized as a value judgment made by an individual, from the point of view of some stakeholder.

Even though success continues to be recognized as central to both theoretical development and the practical applications of information systems, the factors that influence its success in the different settings are not fully understood. Theorists, however, are still grappling with the question of which factors best represent IS success. The problem lies in the ambiguity of the concept and the multiplicity of IS success factors pervading the research (Marquez and Blanchar, 2004; Rai *et al.,* 2002). Leclercq (2007) confirms this when he says that any IS takes root in an organizational context, made of human, social and political interactions. In addition, the measurement of information systems success is complex and illusive (Petter *et al.,* 2008). Another challenge is the role of soft factors such as motivation and perceptions, which have not been appreciated much in IS evaluation literature (Williams, 2004; Caulfield and Maj, 2002). The omission of soft variables may lead to the risk of failing to capture something essential to driving human affairs.

IS success has often been defined as a result or outcome; or a favorable result or outcome (Petter *et al.,* 2008; Alaranta, 2005; DeLone and McLean, 2002). Consequently, mastering information systems and understanding their impacts have become strategic stakes for organizations who must henceforth assure themselves of the performance of the information systems that they use (Leclercq, 2007). The success of an information system has progressively appeared as a result of a combination of processes of which the unfolding is closely linked to the perceptions and behavior of individuals. In addition to understanding information systems, we must also understand decisions that managers make regarding IS investments and their impact on the eventual success of the IS systems that are put in place (Khalifa and Liu, 2004; Reicks, 2001; Murphy and Simon, 2002; DeLone and McLean, 1992).

The success and the eventual cost of the IS investment depends on the decisions that managers make. When making these decisions, it is important for them to be well informed with quality information, so as to come out with informed decisions. Murphy and Simon (2002) state that "quantitative techniques can be hard to apply to activities in which

information is the key commodity". Murphy and Simon (2002) contend that "many of the measures found in the IS literature that are used to evaluate system success are intangible" and that "traditional methods of project evaluation fall short if these measures cannot be quantified in monetary terms".

In their work on system success, DeLone and McLean (2003; 2002; 1992) observed that system quality and information quality are related to system development; and system use and user satisfaction are relevant to implementation. In this study, system use and customer satisfaction reflect expectations of the customer. DeLone and McLean (2002) state that information quality and system quality, are the most important quality components to measure the success of an IS in an organization. On the other hand, Reicks (2001) states that "most people want access to the right information, as they recognize that sharing the right information with the right people at the right time, can empower these individuals". This helps them make the right decisions. Khalifa and Liu (2004) conclude that perceived benefits (IS success) are measured by expectations, ease of use and perceived usefulness.

1.2 The Context of Developing Countries

'Developing countries' is a generic term used to refer to a group of nations that require equitable and sustainable social and economic growth. Developing countries are many and heterogeneous. The World Bank (2010), classifies such countries as developing economies. Low income countries have Gross National Income (GNI) per capita $ 995 or less; while lower-middle income is $ 996-3945 (see Table 1.1). Typical characteristics of developing countries include *low growth of income per capita*, *an inadequate infrastructure situation*, *low literacy levels*, *low life expectancy*, *high mortality rate of children under 5* and *a large population* (Yonazi, 2010).

Table 1.1: Categorization of Countries by Income

Category	Income Group	GNI per capita in 2009 (USD)
Developing Countries	Low income or less	995
	Low middle income	996-3945
Developed Countries	Upper middle income	3946-12195
	High income	12196+

Source: World Bank, 2010

Uganda is a least developed country. As of January 2011, there are 48 countries classified as "least developed". LDCs are distributed across the world, with the majority (33) being located in Africa, followed by 13 countries in Asia and the Pacific, and one each in the Americas (Haiti) and the Arab States region-Yemen. Their total population was estimated in 2008 to be 815 million, of which, over 72 per cent lived in rural areas and was dependent on agriculture for subsistence (ITU, 2011; Imran and Gregor, 2010; UNCTAD, 2010). While this group of countries differ in their territorial extension, population and social cultural characteristics, they are all low-income developing economies facing severe structural impediments to growth as indicated by their high vulnerability to external economic shocks, low levels of human capital, and susceptibility to natural and man-made disasters and communicable diseases (UNCTAD, 2010).

Developing countries have invested heavily in information systems in order to benefit from advances in information technology (IT). IT enables firms to redesign business processes, strengthen their customer relationship management, and develop new business models. Information-intensive business organizations are utilizing IT to create new knowledge, manage existing knowledge, distribute information and facilitate inter-organizational collaboration (Lee, 2004).
While the goal of the use of advanced technology in developing countries is to accelerate development, these countries usually lack the skills and procedures that underpin the technology (Ikem, 2005). Nevertheless, there are many indications that, in developing countries, endemic problems hinder both the completion of IS innovation initiatives and the realization of their expected benefits (Avgerou, 2008). According to a survey carried out by e-Government for Development, 35% are total failures, 50% are partial failures while only a paltry 15% are successes (eGov4dev, 2008).

IS can positively influence organizations and the way they do business. The usefulness and impact of IS has been widely discussed and is evident in many organizations (Avgerou, 2008; Laudon and Laudon, 2007). For instance in Uganda, these can be seen in the banking, revenue collection, health and education sectors. As a result, organizations in Uganda are increasingly implementing IS in order to bring about improved services and productivity (World Bank, 2010). In doing this, developing countries rely on technologies transferred from the developed countries. According to Heeks (2002), the appropriateness of these technologies, and their usefulness in bringing about essential changes for the developing countries have been disputed. These technologies are often unsuitable, and costly

to implement and maintain within the social, economic, political, and cultural context of developing countries. Developing countries are debt riddled, and in terms of innovation and technology, most are passive adopters. In contrast, implementation capabilities are readily addressed and available in developed countries where IS is modeled, designed and developed (Kelegai, 2005). IS practitioners in developing countries often fail to understand the disparities between the developed and developing countries, particularly the environmental factors that influence IS success.

Contextual Differences Between Developing and Developed Countries

The contextual differences between developing countries and developed countries, and their implications for IS success have been highlighted in numerous studies (Kelegai, 2005; Higgo, 2003; Heeks, 2002). Developing countries rely on technologies transferred from developed countries, and yet these technologies are costly to implement and maintain within the economic, political and cultural context of developing countries (Higgo, 2003; Heeks, 2002). Higgo (2003) states that the information system is influenced by both the organizational context in terms of its strategies, structures, politics and culture, and by the wider political socio-economic, cultural and technological climate within which organizations exist. An understanding of the context in which IS is embedded is important and must be seriously considered because environmental forces influence the success or failure of IS (Kelegai, 2005; Enns and Huff, 1999).

An organization's external environment comprises customers, raw materials, technology, laws and regulations, finance, competitors to mention but a few. The external environment forces are just as significant for developed and developing countries, but these forces are increasingly significant for developing countries due to the inherent political, cultural and economic difficulties faced by these countries. In order to improve our understanding of issues involved in implementing systems in developing country contexts, it is useful to consider differences in the contextual features of such systems from those of similar systems in developed country contexts (Krishna and Walsham, 2005). A discussion of these issues is presented below:

1. **Economic factors**. The majority of the economies are agriculturally based. The growth in relation to the economy in these countries is relatively slow, and is impeded by the limited capabilities such as that in human resource, IT infrastructure, policy and legal framework (Kelegai, 2005). It is also impeded by political and social

instabilities. A 2010 World Bank report (World Bank, 2010) suggested a 6 percent growth rate in the economy of Uganda for the period 2007-2009, a rate that is too slow compared to that of developed countries. The report goes further to state that structural changes and genuine and sustainable poverty reduction have been of a rather limited nature. The report adds that Uganda has not made any fundamental changes in outlook and orientation. In a situation like this, IS may fail due to lack of enough resources to maintain the information system, which need a sound economic base to function.

2. **Cultural factors**. The success of IS can be influenced by the work culture in which IS are implemented (Dirksen, 2001). Culture is something that is perceived and felt, hence cannot be precisely defined (Olutimayin, 2002). In relation to developed countries, the creative potential of employees in developing countries is rather limited due to lack of exposure. In the end the employees and managers do not value time and tend to have power concentrated at the top level of management, as opposed to developed countries where there is greater power sharing (Hofstede, 1997).

3. **Political factors**. Political and social stability is a crucial factor that affects IS success in developing countries (Kelegai, 2005). The common characteristic of the political environment in most developing countries is that of volatility and instability as well as upheavals. According to the UNDP (2010) report on Uganda, widespread patronage has been a discernible feature of Ugandan political culture for a long time. This trickles down to how organizations, including IS organizations are run. Political instability contributes to policy instability, loss of investor confidence and social upheavals. Sometimes this leads to political intervention and nepotism. Decision making along formal procedures are hardly adhered to as managers now conflict with the formal procedures. This in the end results in high turnover rates of managers in developing countries.

It is argued that if practitioners are aware of the factors that lead to IS success and address them, the system is more likely to succeed (Kelegai and Middleton, 2004). In addition, the level of knowledge and literacy as well as management understanding of IS contributes to the management perception of IS, its responsibilities, usefulness and strategic value to the organization (Rezaei *et al.,* 2009), leading to better chances of IS success. A summary of the foregoing discussions on the environment in which IS are implemented is presented in Table 1.2.

Table 1.2: Environmental Factors Between Developed and Developing Countries (*Source: Kelegai, 2005*)

Environmental Factors	Developing Country	Developed Country
A. Economic Factors		
Labour (IS Professionals)	scarce	abundant
Agricultural/Industrial Capital	agricultural	industrial
GNI	less than US $744	greater than US $15000
Inflation	high	low
Information Infrastructure	weak	strong
Technology Flow	recipient	donor
Technology Availability	scarce	abundant
B. Political Factors		
Instability	high	low
Institutions	weak	strong
C. Work Culture		
Creative Potential	limited	unlimited
Time perspective	past and present	future-oriented
Time units of action	short term	long term
Success orientation	moralism	pragmatism
Environment	context dependent	context independent
People orientation	paternalistic	participative

IS in Developing Countries

Many researchers (Sabherwal *et al.,* 2006; DeLone and Mclean, 2003, 2002, 1992; Seddon *et al.,* 1999; Torkzaddeh and Doll, 1999; Seddon and Kiew, 1994; Bailey and Pearson, 1983), have come up with various models of IS success. However, the failure rate of information systems in developing countries is still a matter of concern. Heeks (2002) states that "There is no evidence, nor is there any theoretical rationale, to support the idea that failure rates in developing countries should be any lower than figures in the North. There is evidence and there are plenty of practical reasons such as lack of technical and human infrastructure to support the idea that failure rates in DCs might be higher, perhaps considerably higher, than this threshold".

The effective implementation of IS can have a major positive impact, measured economically and otherwise on organizations. Organizations in developed and developing countries now use IS to improve their work processes and service delivery to benefit their customers.

Information systems failure occurs quite often in developing countries for several reasons, including, but not limited to: *bribery, lack of organizational learning, lack of top management support, changing requirements over the life-cycle of the system, failure to retain skilled personnel because of poor remuneration, lack of knowledgeable personnel, corruption* and *waves of staff retrenchment due to uncoordinated privatization* (Mulira, 2007).

When implementing information systems in the developing countries, a lot can go wrong. Since information systems are influenced by the contextual settings in which they are implemented, and that these conditions differ between developed and developing countries (see Table 1.2), it is useful that the elements in these settings be investigated and analyzed, since they influence the way organizations function.

1.3 Research Problem and Questions

Literature on IS implementation shows that most attempts by developing countries to implement information systems (IS) have resulted in failure because several factors in the context of developing countries where the IS were intended to be implemented were not taken into consideration (Kelegai, 2005; Krishna and Walsham, 2005; Heeks, 2002). For an IS to be termed a failure, there are usually three perceptions, that is being too expensive, being too late or being of poor quality. In many cases, these are interrelated (Henderson, 2006). Quality in an organization is defined in terms of quality as excellence, quality as value, quality as conformity to specifications, and quality as meeting customer expectations (Gorla *et al.,* 2010). Excellence in IS quality involves using state-of-the-art technology, following industry best practice software standards, and delivering error-free performance. IS quality as conformance denotes designing systems that conform to the end users information requirements and adhere to industry standards. Meeting customer expectations of IS quality is accomplished by offering appealing, user-friendly interfaces, entertaining user requests for changes, and satisfying the stakeholders of the IS (Gorla *et al.,* 2010). From the foregoing, the main challenge is to sustain working information systems over long periods of time. This failure is also a problem because of the opportunity cost of resource investment in failure as opposed to success. Such opportunity costs are particularly high in developing countries because of the more limited availability of resources such as capital and skilled labor.

Krishna and Walsham (2005) state that implementers of IS systems in developing countries need to address the specific contextual characteristics of the organization, sector, country or region within which their work is located.
As calls for greater accountability arise and larger IS are being implemented, IS managers find themselves making decisions about information and information technology for which they are unprepared or ill-equipped (Ho and Pardo, 2004). Rezaei *et al.,* (2009) are of the view that the level of knowledge and literacy, and management understanding of

IS, contributes to the management perception of IS, its responsibilities, usefulness and strategic value to the organization; leading to better chances of success.

If we are able to empower the manager of an IS, then it is more likely that we can start posting success in IS implementations in developing countries. Many solutions have been proposed to help managers with their IS, using general accounting methods, balanced score cards and the like. The methodologies that are recommended by industry and academia are in most cases, hardly known by managers and practitioners and where they are aware; they are rarely used in practice (Brown, 2005).

The perspective of an IS is that its organizational role is to support decision making activity. The important factors supporting decision making are the information received, the decision aids provided and the delivery system which serves as the interface between the IS user and the IS (Petter *et al.,* 2008; DeLone and McLean, 2003; Rai *et al., 2002*; Seddon *et al.,* 1997).

The problem presented highlights the need to provide an approach to support decision-making to IS managers to ensure IS success in developing countries. Uganda, a developing country (see Tables 1.1 and 1.2), has the same characteristics that have been highlighted for other developing countries (Mulira, 2007; Heeks, 2002), and thus served as our case study context. According to Sol and Hengst (2001), the current era is characterized by high competition, high information flow, high demand for timeliness and accuracy of information, change of business needs, and change of customer needs. In addition to these, IS are becoming more complex, involve time delays and feedback (Sterman, 2000). Under such circumstances, managers need to have insight into factors that will ensure information systems success.

This resulted in the following main research question: *What are the issues influencing information systems success in developing countries and how can we design an approach to improve the prospects of IS success?.*

To answer this question, we developed a number of specific research questions as elaborated below:

Research Question 1

What theories can be used to explain IS success?

This question was intended to help us gain a detailed understanding of the available IS success theories. It also facilitated our analysis of the relevance of the theories as well as their application in developing country contexts. This understanding was crucial in highlighting theoretical gaps, gaining useful insights for future activities, and deciding on

the relevant research method that we could use in this study. The question is partially answered in Chapter 1 and will be further elaborated in Chapter 2. This gives rise to the following question.

Research Question 2

How should a solution for assessing IS success in developing countries look like?

Providing answers to this question enabled us to identify requirements for a solution to support IS managers in improving the prospects of achieving IS success in developing countries. This question is answered in Chapter 4. Answering this question, we were able to ask the following question.

Research Question 3

How can we develop a solution aid stakeholders in improving prospects for IS success in developing countries?

After identifying the requirements for the solution, we went ahead to design and implement the solution. This question is answered in Chapter 5. A description of experiments that were carried out by the researcher and IS managers is also documented. By answering this question, it gave rise to the following question.

Research Question 4

How can we evaluate the solution to provide support to IS managers in developing countries in improving prospects of achieving IS success?

This question was answered in Chapter 6 using three case studies targeting IS managers in three organizations; namely Makerere University, Barclays Bank and National Water and Sewerage Corporation. During the sessions in the case studies, the users get acquainted with the solution, then use it to assess the IS of their choice and communicate the insights gained to colleagues. It is here where users also evaluate the solution for its usefulness and usability.

The answers to these questions contributed to achieving the research objective.

1.4 Research Approach

The notion research approach refers to the approach or the methodology that has been adopted to conduct the research. It basically involves the selection of a research philosophy, a research strategy that is adopted, and the selection of the appropriate research

instruments (Muniafu, 2007).

Research Philosophy

Information systems and the organizations they support are complex, artificial, and purposefully designed because they are composed of people, structures, technologies, and work systems (Hevner *et al.,* 2004).
Research is based on some underlying assumptions about what constitutes valid research and which research methods are appropriate. We thus need a research philosophy that can unravel the complexity to enable us understand the whole process. The research philosophy underlines the way in which data on the phenomenon studied is collected and analyzed (Muniafu, 2007). Every philosophy has a distinct way of explaining the nature of reality (ontology), knowledge (epistemology) and values (axiology). Thus different philosophies will yield different results (Cohen *et al.,* 2003).

There are three major paradigms for research: *positivism*, *anti-positivism* also known as *interpretivisim*, and *critical theory/realism*.

The *positivist paradigm* is based on the philosophical ideas of August Comte (1798-1857), who emphasized observation and reason as means of understanding human behavior. According to him, true knowledge is based on experience of senses and can be obtained by observation and experiment (Cohen *et al.,* 2003). The positivist paradigm is the background to the scientific method and has been very influential to both philosophers and social scientists where each school of thought takes a given stance parallel to that of natural science (Iivari, 2007; Cassel and Johnson, 2006; Schmenner and Swink, 1998; Camerrer, 1985; Hempel, 1965; Popper,1978; 1963). This means that their analyzes must be expressed in laws or law-like generalizations of the same kind that have been established in relation to natural phenomena (Cohen *et al.,* 2003). Positivism seeks to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements (Iivari and Venable, 2009; Burrel and Morgan, 1979). Nonetheless, it is criticized due to its lack of regard for the subjective states of individuals. It regards human behavior as passive, controlled and determined by external environment. In this way, humans are dehumanized without their intention. It is argued that the objectivity of the scientific method needs to be replaced by subjectivity in the process of scientific enquiry. This gave rise to anti-positivism or the interpretive

paradigm.

Anti-positivism or the *interpretive paradigm* advocated by Burrel and Morgan (1979), states that social reality is viewed and interpreted by the individual according to the ideological position the researcher possesses. It also attempts to understand how humans make sense of their surroundings (Saunders *et al.,* 2000, Burrel and Morgan, 1979). In this paradigm, knowledge is personally experienced rather than acquired from or imposed from outside.

The *anti-positivists* believe that reality is multi-layered and complex (Cohen *et al.,* 2003) and a single phenomenon is having multiple interpretations. Anti-positivism maintains that the social world can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied. One can only understand by occupying the frame of reference of the participant in action (Iivari and Venable, 2009; Niehaves, 2007; Cassel and Johnson, 2006; Iivari and Ervasti, 1994; Burrel and Morgan, 1979).

While positivism stands for objectivity, measurability, predictability, controllability and constructs laws and rules of human behavior (Iivari, 2007), anti-positivism essentially emphasizes understanding and interpretation of phenomena and making meaning out of this process (Iivari, 2007).

Alongside the presence of these two major paradigms, another trend, which got developed during the post-sixties, gave rise to the third paradigm of research namely the paradigm of critical theory/realism. In critical theory/realism, advanced by Jurgen Habermas (Habermas, 1970), it is believed that there is a reality independent of our thinking that can be studied. However, it is recognized that reality cannot be known with certainty (Trochim, 2006).

Habermas (1970) postulated three types of interest which generate three types of knowledge: A technical interest concerned with the control of the physical environment, which generates empirical and analytical knowledge; a practical interest concerned with understanding the meaning of situation, which generates hermeneutic and historical knowledge; and an emancipating interest concerned with the provision for growth and advancement, which generates critical knowledge and is concerned with exposing conditions of constraints and domination. Critical theory has been criticized by some of the contemporary scholars. Lakomski (1999) questions the acceptability of the consensus theory of truth on which Habermas work is premised. Habermas work is little more than speculation. Whilst the claim to there being three forms of knowledge has the epistemological attraction of

simplicity, one has to question this very simplicity (Keat, 1981); there are a multitude of interests and ways of understanding the world; and it is simply artificial to reduce these to three interests (Cohen *et al.,* 2003).

Following Weber, Lin, and Trauth and Jessup (Weber, 2004; Trauth and Jessup, 2000; Lin, 1998) the research in this thesis should not be labeled as positivist or interpretivist, rather, the two will be complementing each other since we are dealing with both people and information systems.

To enable us to use both paradigms, we used a research philosophy, known as design science (DS), that can be used for research in information systems (Hevner *et al.,* 2004). The goal of this research was to improve IS success in developing countries by providing support to IS managers to enable them assess their IS. We therefore followed the design science philosophy based on the discussion by Hevner *et al.,* (2004), which states that the design science paradigm is used in information systems to address what are considered ill-structured problems. Hevner (2007) states that the designed artifact must be useful to information systems practitioners, emphasizing its utility, and that exercising the artifact in the problem domain should add value to the information systems practice.

Design science is aimed primarily at discovery and problem solving as opposed to accumulation of theoretical knowledge (Holmstrom *et al.,* 2009). Design science seeks to develop artifacts composed of constructs, models, methods and instantiations that solve a particular problem (Cole *et al.,* 2005; Hevner *et al.,* 2004).

DS is a problem solving paradigm used to create and evaluate IT artifacts intended to solve identified organizational problems (Winter, 2008; Carlsson, 2007; Hevner *et al.,* 2004). Winter (2008) stresses that design science aims at producing artifacts that contribute to the body of knowledge and are relevant to the community. It therefore involves the analysis of the use and performance of designed artifacts to understand, explain and, very frequently, to improve the behavior of aspects of information systems (Muniafu, 2007). Iivari and Venable (2009) define DS as a research activity that invents or builds new, innovative artifacts for solving problems or achieving improvements; that is DS creates new means for achieving some general goal, as its major research contributions. Such new and innovative artifacts create new reality, rather than explaining existing reality. The key differentiator between routine design and design science is the clear identification of a contribution to the archival knowledge base of foundations and methodologies (Hevner *et al.,* 2004).

Hevner (2007) lays emphasis on three inherent research cycles. The three cycle view of design science suggests that *relevance* is attained through identification of requirements (or business needs) (addressed by research questions 1 and 2) and field testing of an artifact within an environment, while *rigor* is achieved by appropriately grounding the research in existing foundations, methodologies and design theories and subsequently making contributions that add to the existing knowledge base (answered by research question 2). The design aspect is achieved through a *design cycle* (answered in research question 3), in which the artifact must be built and evaluated thoroughly (answered by research question 4), before "releasing" it to the relevance cycle and before the knowledge contribution is output into the *rigor cycle* (Hevner, 2007).
These cycles are illustrated in Fig. 1.1.

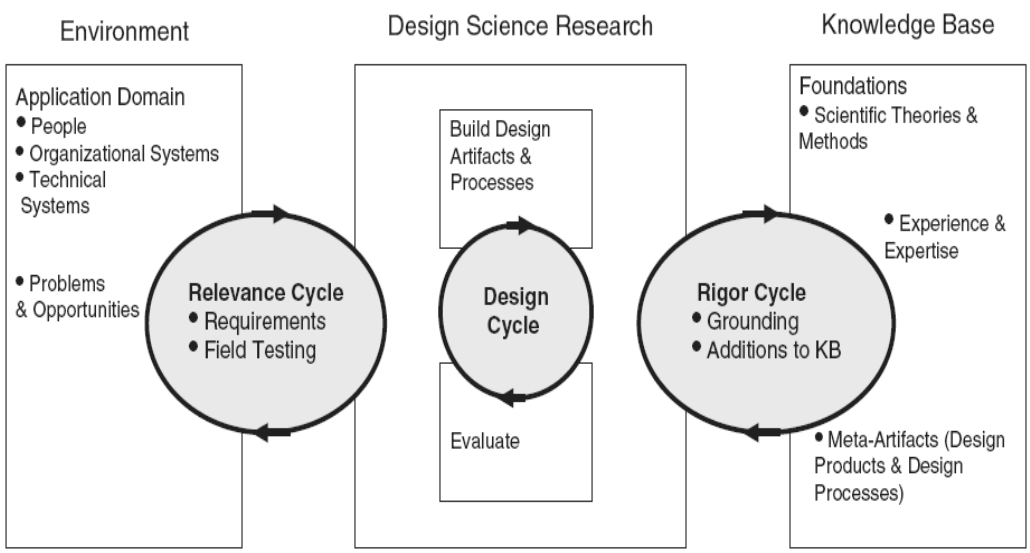

Figure 1.1: Design Science Cycles[based on Hevner, 2007]

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Inductive Hypothetic Research Strategy

Nabukenya (2009) describes a research strategy as an ordered set of steps followed when inquiring into the phenomenon being investigated (see also: Trochim, 2006; Neuman, 2003; Creswell, 1994; Churchman, 1971). The design science

Our research strategy, which outlines the steps to be taken in a scientific inquiry to meet

the research objective, is the inductive-hypothetical model cycle (Sol, 1982), that is based on a Singerian strategy (Churchman, 1971). In the inductive-hypothetical model cycle, knowledge about the research problem and feasible solutions are obtained by adaptation through induction and multidisciplinary view of new observations (Tewoldeberhan, 2003). The Singerian strategy can be characterized by adapting it endlessly, inductively and in a multidisciplinary manner based on new observations (Sol, 1982; Churchman, 1971). According to Sol (1982), the main benefits of the inductive -hypothetic strategy are the following:

-it emphasizes the specification and testing of premises in an inductive way.

-it opens up possibilities of an interdisciplinary approach.

-it enables the generation of various alternatives for the solution of the problem.

-it permits feedback and learning.

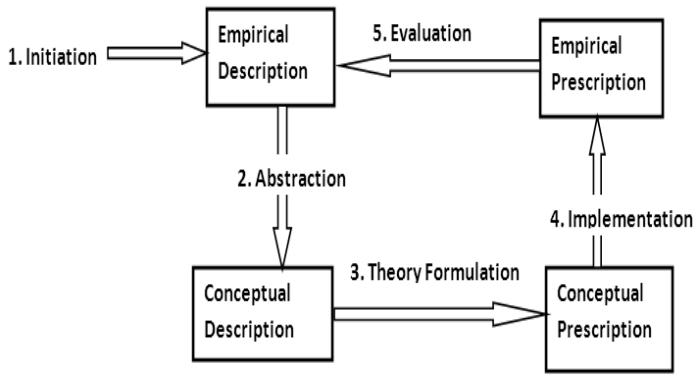
These benefits make the inductive-hypothetic strategy very useful for new and emerging research fields such as information systems success in developing countries. This research aims to explore and find meaning of IS success in developing countries.

The inductive hypothetic research strategy complements the design science philosophy. We defined our lens and started our research with an initial theory, which we refer to as the first conceptual model. This was followed by an exploratory study, which is implicitily described as an empirical descriptive model. The empirical descriptive model was then generalized as a descriprive conceptual model, that we refer to as a refined model. From the understanding gathered from the exploration and induction, we came up with a way to enhance the assessment and training as well as acceptance of IS in developing countries. From the knowledge gained, we developed propositions that take the form of a design of our studio, which was then tested with stakeholders of IS in Uganda.

The strategy as shown in Figure 1.2, is organized around the execution of five steps using four model types.

Initiation Stage

In this stage, theories about information systems success were studied from literature to gain an in-depth understanding and case studies carried out in IS organizations in Uganda in order to get to understand further, the factors that ensure information systems success.



. Figure 1.2: The Inductive-hypothetical Research Strategy [based on Sol, 1982]

Abstraction Stage

The gathered information was summarized and then analyzed to identify key drivers for IS success, as well as derive functional requirements for a solution for IS success. The requirements provided the conceptual description of what the designed artifact should provide.

Theory Formulation Stage

Basing on the derived requirements, Sol's descriptive framework for design approaches (Van de Kar, 2004) was followed to design an instrument for assessment of IS. This design framework provided the conceptual description of what should constitute the required solution.

Implementation Stage

In this stage, a number of System Dynamics models were built, which enables creation of a simulation environment which stakeholders can use to carry out experiments and assess an IS of their choice.

Evaluation Stage

In this stage, the developed instrument was subjected to testing at different case study organizations using sessions with different stakeholders. The aim of testing the instrument was to evaluate its usefulness, usability and usage as far as assessing IS is concerned. Feedback from the stakeholders was gathered using questionnaires and interview.

1.5 Outline of the Thesis

The outline of the thesis, is related to the research strategy as presented in Figure 1.2 and covers seven (7) chapters. In this section, we give a brief description. We deal with the problem field in Chapters one and two, which relates to the initiation stage of the research. Chapter one starts with the introduction about information systems success. It highlights the contextual differences between developed and developing countries and illustrates why there should be different approaches in assessing IS success in the two environments. Insights into theories about information systems success are provided in Chapter two where we reviewed a number of models that are used to assess IS success.

Chapter three, which relates to the last part of the initiation stage of the research, presents the exploratory study which enhances our understanding of information systems success in developing countries. We studied information systems success in the application domain. We considered the application domain of IS success as there, where information systems are designed, implemented and maintained. Information systems in Uganda are mainly implemented by large business and government institutions.

In Chapter four, which relates to the theory formulation stage of the research strategy, the information output from the initiation and abstraction phases was used to design the IS assessment instrument. In Chapter five, an account of the activities that took place during the implementation stage is given. It describes how the designed IS assessment instrument was realized.

Chapter six presents the evaluation phase where case studies, interviews, questionnaires and expert opinion were used to evaluate the solution. In the test sessions documented in this chapter, users get acquainted with the solution, use the solution to assess the IS of their choice and communicate the insights gained to colleagues. It is here where users also evaluate the solution for its usefulness and usability. Chapter seven concludes with the discussion of the findings, conclusion and recommendations for future work.

2. IS Success and IS Decision Making

2.1 Review of Current IS Success Theories

The importance of investing in new information systems (IS) architectures and infrastructures has become a topical issue within organizations. This is predominantly motivated by the need to deliver better value products and service through robust and responsive supply chains. With this in mind, business managers are seeking to use appropriate methods and techniques to appraise and justify the financial contribution of IS at strategic, operational and tactical levels. Yet, managers often express concern regarding their ability to appraise IS investments prior to committing financial and emotional resources (Irani, 2008).

Information systems success is considered critical to the field of information systems (Sabherwal *et al.,* 2006). A review of literature reveals that a lot of research has been undertaken to measure the success of information systems (see for example Petter *et al.,* 2008; DeLone and McLean, 1992, 2002, 2003; Seddon, 1999; Seddon *et al.,* 1999; Hunton and Flowers, 1997). The concept of IS success is widely accepted in IS research as the principal criterion for evaluating information systems (Rai *et al.,* 2002).

In the following sections, we attempt to explore and compare the various IS success theories that are available for measuring IS success.

DeLone and McLean Theory (1992)

Early attempts to define information system success had difficulty in handling the complex, interdependent, and multi-dimensional nature of IS success.

To address this problem, DeLone and McLean (1992) performed a review of the research published during the period 1981 to 1987, and created a taxonomy of IS success based upon this review (Petter *et al., 2008*). The DeLone and McLean theory of IS success (1992), as illustrated in Figure 2.1, was an attempt to prescribe a single theory of IS success. It consisted of six constructs: *system quality, information quality, use, user*

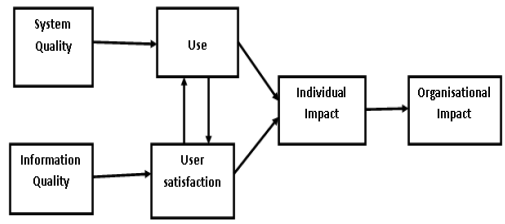


Figure 2.1: DeLone and Mclean Theory of 1992

satisfaction, individual impact and *organizational impact*. Constructs are a high-level description of the system that is being built; and are used for modeling the structure of business processes (Seila *et al.,* 2003). The theory was based on the ideas by Shannon and Weaver (1949) and Mason (1978). The arrows indicate a causal relationship and are directions of influence. According to Shannon and Weaver (1949) as well as Mason (1978), problems are present in three hierarchical levels: a technical level, a semantic level and an effectiveness level. The technical level concerns how well the system transfers the symbols of communication, the semantic level concerns the interpretation of meaning by the receiver as compared with the intended meaning of the sender, and the effectiveness level relates to how well the meaning conveyed to the receiver affects actual behavior.

In terms of the DeLone and McLean taxonomy, system quality belongs to the technical level, and information quality belongs to the semantic level (Rai *et al.,* 2002). Other researchers like Hunton and Flowers (1997) and Seddon and Kiew (1994) found support for the relationships of the DeLone and McLean theory at the time.

Seddon *et al* IS Effectiveness Theory (1999)

Seddon *et al* (1999) modified the DeLone and McLean theory (1992). The major difference between the two theories is the definition and placement of IS use. Seddon *et al* argue that use must precede impacts and benefits, but it does not cause them. They consider IS use as behavior that reflects an expectation of net benefits from using an information system and therefore model IS use as resulting behavior of IS success.

Seddon's *et al.* (1999) reformulation of the DeLone and McLean theory into two partial variance models complicates measurement, whereas the original desire for formulating a theory for IS success was simplicity (see section 2.1).

DeLone and McLean Theory (2002)

In this theory, DeLone and McLean revisited the 1992 theory and carried out refinements taking into account the numerous criticisms and suggestions for improvement from other researchers. This modified theory is illustrated in Figure 2.2 below; where the arrows represent influence.

The key changes were: the introduction of net benefits (replacing individual impact and organizational impact in the original theory), a re-specification of the relationships among constructs and the construct "service quality" was added to the D&M model.
The constructs are explained below:

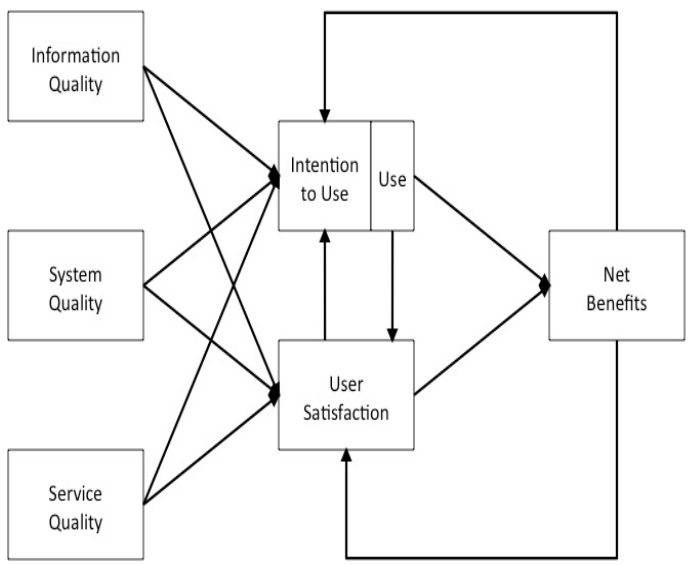


Figure 2.2: DeLone and Mclean Theory of 2002

User Satisfaction
User satisfaction is the net feeling of pleasure or displeasure resulting from aggregating all the benefits that a person hopes to receive from interaction with the information system. Each user has a set of expected benefits or aspirations for the information system. To the extent that the system meets or fails to meet each of these aspirations, the user is more or less satisfied (Seddon and Kiew, 1994). When the use of an information system

is required, the preceding measures become less useful; and successful interaction by management with the information system can be measured in terms of user satisfaction (Hoogeveen, 1997; DeLone and McLean, 1992).

Information Quality

Information quality represents the desirable characteristics of the system outputs like relevance, understandability, accuracy, conciseness, completeness, currency, timeliness and usability (Petter *et al.,* 2008). In addition, information quality captures the content and semantic quality of the information that the system produces (DeLone and McLean, 2003). To manage information quality effectively, one needs to know how it changes over time, what causes it to change and whether the changes can be predicted. The quality of outcomes of individual and institutional processes is often determined by the quality of the information that is used. Because decision making is linked to information quality, effective and efficient management greatly depends on good quality information.

System Use

Just as User satisfaction, Systems Use concerns the effectiveness/influence level and examines actual and reported use of systems (DeLone and McLean, 2003; Ives *et al.*, 1980). In the dynamic environment which considers responses to requirements change, the use of systems includes use of technical tools and procedures and so on which contribute to effective requirements specification, as discussed by Williams (2004). Lack of top management support is considered a critical barrier to effective IS use (Lin, 2010; Dong *et al.,* 2009; Young and Jordan, 2008; Ifinedo, 2008; Liang *et al.,* 2007; Ifinedo and Nahar, 2006; Sharma and Yetton, 2003; Guimaraes and Igbaria, 1997).

System Quality.

According to DeLone and Mclean(2003), this is the quality of IS from the technical/production perspective. It is related to utilization of the system. Symbolic actions of support by senior managers also contribute to successful implementation (Sharma and Yetton, 2003).

Service Quality

Service quality concerns the quality of the IS team and relates to reliability, responsiveness, assurance and empathy (DeLone and Mclean, 2003).

Net Benefits

This construct is at the organizational level or above (eg industry or national) and measures the effectiveness and influence of the information system (DeLone and Mclean, 2003). In the DeLone and McLean theory, Systems use and User satisfaction (which are IS success measures), lead to Net Benefits. Sabherwal *et al.,* state that "Thus, top management support is posited to positively affect all four aspects of IS success" (Sabherwal *et al.,* 2006). The four aspects of IS success that Sabherwal *et al.,* refer to are system quality, user satisfaction, usefulness of the system and systems use. DeLone and McLean (2002) state that "If the information system or service is to be continued, it is assumed that the net benefits from the perspective of the owner or sponsor of the system are positive, thus influencing and reinforcing subsequent Use and User Satisfaction. The challenge for the researcher is to define clearly and carefully the stakeholders and context in which Net Benefits are to be measured". Lin *et al.,* (2007) are of the view that DeLone and McLean's theory neglects some other important constructs that interact with today's technological change.

Wang and Liu Theory of IS Success (2005)

Wang and Liu (2005) proposed a theory that integrated the DeLone and McLean theory and Technology acceptance models (Venkatesh *et al.,* 2003; Venkatesh and Davis, 2000; Szajna, 1996; as shown in Figure 2.3 below:

Their theory was titled The System Dynamics Model of IS Success, and consisted of two reinforcing loops and one balancing loop.

The theory as presented in Figure 2.3, is an influence diagram, with feedback relationships. A feedback relationship is a closed-loop circle of cause-and-effect. Feedback loops could be viewed as relationships that generate goal-seeking behavior. Goal seeking is a fundamental activity in which all dynamic systems engage (Law and Kelton, 2006). In fact, goal seeking is what enables conditions within a system to remain on course. When deviation occurs, feedback relationships inspire and direct corrective actions to bring conditions back in line. There are two types of feedback relationships, negative (counteracting); designated as **B**, and positive (reinforcing); designated as **R**, feedback loops. When any construct in a negative loop is changed, then the loop causes that construct to readjust in the opposite direction. The negative loop produces self-regulating change.

The authors noted that, the major reinforcement loop R1, which is the Benefits from the use of IS adjustment loop, will dominate the behaviours of the model (Wang and Liu,

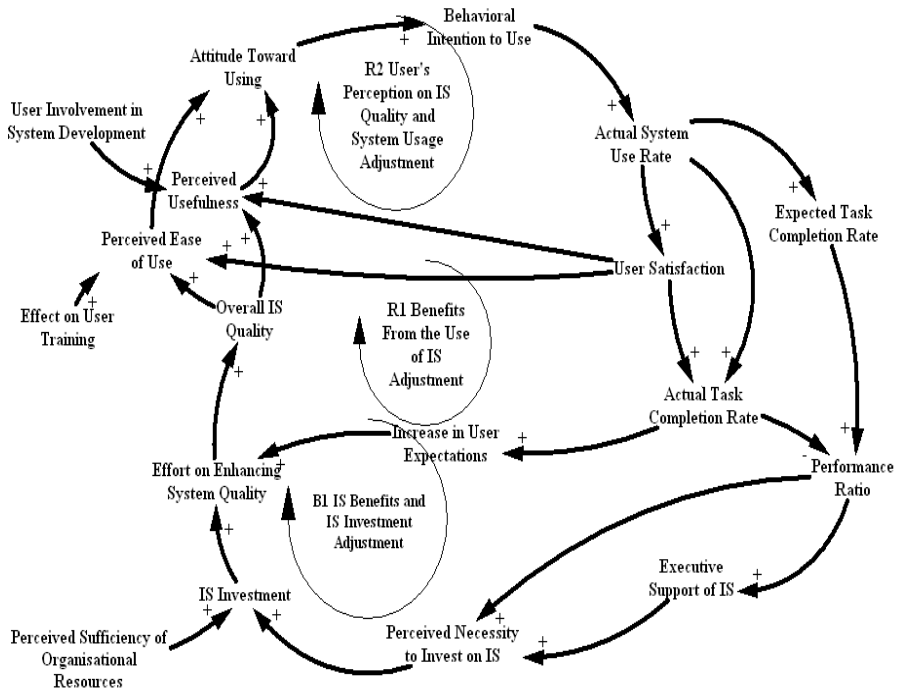


Figure 2.3: Wang and Liu System Dynamics Theory of IS Success, 2005

2005). The complexity of the resulting model makes it difficult to test and verify with the introduction of feedback loops adding to the difficulty of semantic testing. The authors acknowledge the complexity of the model and state that they carried out testing based on only a small number of responses. In their conclusion, Wang and Liu (2005) state that the main weakness of their theory is that it is based on the two specific theories (DeLone and McLean IS model and TAM (Davis, 1989)) and suggest that additional literature review could bring out additional concepts that could be used to refine it. They also accept that their lack of empirical testing and small data set made it difficult to test the constructs effectively.

Sabherwal *et al.* Theory (2006)

Sabherwal *et al.* (2006), developed a theory for IS success taking into account observations made by Rai *et al.* (2002) and Guimaraes and Igbaria (1997) concerning the DeLone and McLean theory (1992). In their theory, they introduced two new constructs: top management support and facilitating conditions. Top management support for ISs refers to the senior executives' favorable attitude toward, and explicit support for ISs. Facilitating

conditions for ISs reflect the processes and resources that facilitate an individual's ability to utilize information systems. When top management is highly supportive of ISs, greater resources are likely to be allocated to develop and support ISs enhancing facilitating conditions for ISs (Sabherwal *et al.,* 2006).

The major drawback of this theory is that it is based on the reported statistics from a large number of prior empirical studies. It thus assumes that it is meaningful to combine results based on different constructs and measures, across different studies (Sabherwal *et al.,* 2006). Secondly, some constructs which had been validated by prior research, like information quality were left out. Moderating effects were also removed due to the inability of the authors to test them (Sabherwal *et al.,* 2006). The authors conclude by stating that the emergent model from this theory best applies to the post-implementation situation and to ISs in organizational contexts.

Gable *et al* IS-Impact Success Theory (2008)

Gable *et al.* (2008) basing on DeLone and McLean (1992) argue that a holistic measure for evaluating an IS should consist of dimensions that together look backward (impacts), and forward (quality).

Gable *et al.,*(2008) define the IS-Impact of an information system (IS) as a measure at a point in time of the stream of net benefits from the IS, to date and anticipated, as perceived by all key-user-groups.

The authors acknowledge that the IS-Impact model was developed and validated with data only from the Australian public sector, and wonder whether the citations used are complete and representative of contemporary IS in general. And apart from their study, this model has not been tested anywhere else (Gable *et al.,* 2008).

2.2 Comparing IS Success Theories

Six IS success theories were reviewed with a view of selecting one for adoption to fit the developing country context like Uganda (see section 2.1). Table 2.1 provides a summary of the comparisons. derivation of the factors for comparing different IS success theories is adopted from Garity and Sanders (1998) and Petter *et al.*, (2008). One of the criteria for selection of a model for use is that users should have confidence in the theory. In order for users to have confidence in the theory it has to be well tested and validated (Petter *et al.*, 2008). Another criteria for selection is the application area, that is at what level the model is going to be used. The application area represents the flexibility of the theory to be applied to the level of analysis the researcher considers most relevant.

Simplicity is defined as freedom from difficulty. Simplicity usually relates to the burden which a thing puts on someone trying to explain or understand it. Something which is easy to understand or explain is simple, in contrast to something complicated (Hornby, 2002). *Flexibility* is defined as being capable of adapting (or of becoming or being made suitable) to a particular situation or use (Hornby, 2002).

IS can be measured at 3 levels (Garrity and Sanders, 1998).

1. Firm or organizational level measures of success.
2. Function or process level measures of success.
3. Individual measures of success.

At the organizational level, IS success can be measured primarily using measures related to organizational performance. This includes increased market share and/or profitability, operating efficiency, operating cost and return on equity and stock. At the function or process level, the IS can be measured in terms of the efficient use of resources and by the reduction of process cycle times. Finally, at the individual (or user) level, the IS can be measured in terms of each user's perception of utility and satisfaction (Garrity and Sanders, 1998).

Table 2.1: Comparing Success Theories

Model and Criteria	DeLone and McLean, 1992	Seddon *et al.*, 1999	DeLone and McLean, 2002	Wang *et al.*, 2005	Sabherwal *et al.*, 2006	Gable *et al.*, 2008
Well Tested and Validated	Yes	No	Yes	No	No	No
Simplicity	Yes	No	Yes	No	Yes	Yes
Captures all Factors Relevant to DCs	No	No	No	No	No	No
Flexible	No	No	Yes	No	No	No

Of all the theories reviewed, the DeLone and McLean 1992 and 2002 were the most tested and validated (Petter *et al.*, 2008; Wang and Liu (2005); Seddon *et al.*, 1999; Seddon and Kiew, 1994).

A challenge that was identified for developing countries is lack of knowledgeable staff (Mulira, 2007). Consequently, a theory for use in a developing country context needs to be simple to use. Theories (DeLone and McLean, 1992 and 2002; Sabherwal *et al.,* 2006; and Gable *et al.*, 2008) were the ones that exhibited simplicity. On the other

hand (Seddon *et al.*, 1999) is the most complex of all theories. Of all theories reviewed, the DeLone and McLean (2002) model was deemed flexible for use in a developing country.

Petter *et al.,* (2008) state that the early attempts to define information system success were not very successful due to the complex, interdependent and multi-dimensional nature of IS success. Some researchers have modified the original DeLone and McLean theory to evaluate specific applications such as knowledge management (Kulkarni *et al.,* 2006; Wu and Wang, 2006; Jennex and Olfman, 2002) and e-commerce (Zhu and Kraemer, 2005; DeLone and McLean, 2004; Molla and Licker, 2001). Because IS success affects work-groups, industries and even societies (Seddon *et al.,* 1999; Myers *et al.,* 1997), DeLone and McLean replaced the constructs, *individual impact* and *organizational impact* with *net benefits*, thereby accounting for benefits at multiple levels of analysis. This theory allowed it to be applied to whatever level of analysis the researcher considers most relevant.

2.3 Related Literature

An integrative model of IT business value based on a resource-based view was developed by Melville *et al.,* (2004). This model has three domains: the focal firm, the competitive environment, and the macro environment, as shown in Figure 2.4.

The focal firm is the organization that is acquiring or deploying the IT resource. The IT resource applied with complementary organizational resources may improve existing business processes or enable new ones. This affects business process performance, which in turn affects organizational performance.

Melville *et al.,* (2004) improve on previous theory by positing the mediating effect of business process on organizational performance, as well as the effect of industry and environmental characteristics. However, this theory also fails to distinguish between differential effects of Information Technology vis-a-vis other resources (Vinekar, 2007). Vinekar further argues that in this theory, Melville *et al.,* (2004) emphasize the importance of combining complementary resources with IT to provide business value, but several other resources may have been substituted for information technology and could have the same effect (Vinekar, 2007).

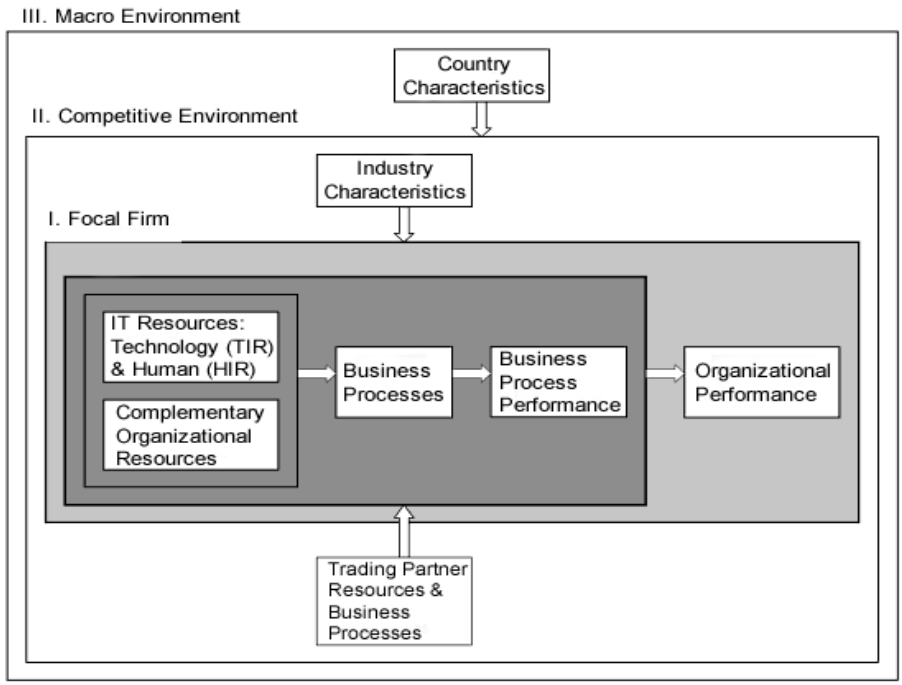


Figure 2.4: Resource-Based View IT Business Value Model [Melville *et al.,* (2004)]

Several researchers in the area of IS success have come up with convincing reasons to show that there are other constructs that are responsible for IS success, other than those in the reviewed theories. We now give an overview of some of these constructs.

Requirements Changes

Because of insufficient planning and simply because projects take a long time from inception to completion most especially in developing countries, there is a requirements explosion during the lifetime of the information system which means that what is eventually required is significantly different from what was originally anticipated (Henderson, 2006). Requirements grow and change over time throughout the system life-cycle, calling for considerable feedback and iterative consultation (Tharkurta and Ahlemann, 2010; Nurmuliani *et al.,* 2006). This is not specifically catered for in the current IS success theories and due to interdependencies, it is difficult to consider a system life-cycle in isolation (Carlshamre *et al.;* 2001).

Requirements Volatility

Despite advances in software engineering, most IS implementations still experience numerous requirements changes during their life cycle, which is brought about by the dynamic nature of development activities (Tharkurta and Ahlemann, 2010; Nurmuliani *et al.,* 2006). Requirements volatility has been reported as one of the main constructs causing IS failure. The rate of requirements volatility is measured as a ratio of the total number of requirements changes (add, delete, and modify) to the total number of requirements in the system over a period of time (Nurmuliani *et al.;* 2006). These changes can take place while the requirements are being elicited, analyzed, and validated, and after the system has gone into service (Ferreira *et al.,* 2009; Mulira, 2007).

Top Management Support

Sabherwal *et al.,* (2006), in their conclusion state that top management support is a strong determinant of IS success. Subsequent research by Hussein *et al.,* (2007) has placed top management support in the area of organizational factors that facilitate IS success, alongside managerial IT knowledge, rather than an IS success dimension (see also Lin, 2010; Masrek *et al.,* 2007; Ho and Pardo, 2004). Referring to Table 1.2, we realize that for developing countries that have paternalistic people orientation, management tends to be very hierarchical; so the issue of top management support is a very important factor that needs exploration. Further, Table 1.2 indicates that there is scarcity of IS professionals, weak information infrastructure and scarce technological availability.

The first exercise in every modeling endeavor is to choose the parts of the investigated system that we wish to capture in our model. Obviously, it would be unrealistic to assume that we can capture each and every part of the system in a model, unless we decide to duplicate the system itself (Forrester, 2007). In this research, we targeted those constructs that were in the reach of control of stakeholders, that is, the stakeholders could through their direct intervention, help improve the situation.

Forrester (2007) argues that "powerful small models" can be used to communicate the most crucial insights of a modeling effort to the public. By small models is meant models that consist of a few significant constructs and at most seven or eight major feedback loops. Small models are unique in their ability to capture important and often counterintuitive insights relating behavior to the feedback structure of the system without sacrificing the ability of policy makers to easily understand and communicate those in-

sights (Ghaffarzadegan, *et al.,* 2010).

2.4 Enhancing Stakeholders Decision Making

Management is a series of decision making processes and the decision making process is at the heart of executive activity in business (Shrianjani and Higgins, 2001).
Decision makers today face problems that are increasingly complex and interrelated (Qudrat-Ullah *et al.,* 2007; Moxnes, 2000; Sterman, 2000; Diehl and Sterman, 1995). Many important decisions routinely made are dynamic in nature in that a number of decisions are required rather than a single decision, decisions are interdependent, and the environment in which a decision is set changes over time (Qudrat-Ullah *et al.,* 2007; Sterman, 2000). But decisions need to be made fast, especially in the current context where the most precious and least manageable commodity available to managers is time (Shrianjani and Higgins, 2001). While corporations and economic systems do not lend themselves well to real-world experimentation, at the same time, most of the real-world decisions and their outcomes are not closely related in both time and space (Qudrat-Ullah *et al.,* 2007).

Decision Enhancement Services

Decision Enhancement (DE) is "a management lens or way to look out at the dynamic and volatile domains of complex private and public sector decision-making and, increasingly, their interdependencies and necessary collaborations" (Keen and Sol, 2008). DE is founded on the long existent decision support systems (DSS) that seek to provide supporting tools or systems to aid stakeholders in making decisions. It aims at providing a process to support stakeholders in making decisions that matter that is, decisions that are "multi-stakeholder, complex, value-dominated, uncertain and consequential" (Keen and Sol, 2008). As a result, decision making processes are enhanced through professional practices that fuse human skills and technology as illustrated in Figure 2.5; bringing together the best of executive judgment and experience with the best computer modeling, information management and analytic methods while facilitating scenario-building and evaluation, collaboration and simulation to rehearse the future (Keen and Sol, 2008).

To achieve decision enhancement, studios have been used to provide an integrative framework to improve the combination or fusion between these three factors. A studio is an environment or shared space or forum designed around process, that contains a set of integrated tools/technologies that enable stakeholders (people) to interactively collaborate to generate and analyze "what-if?" scenarios of the possible solutions to a given problem

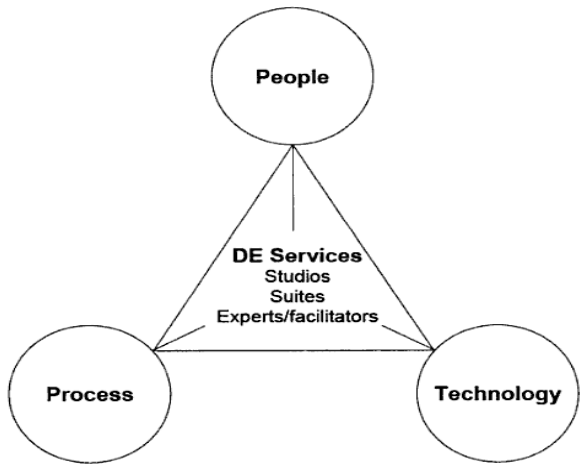


Figure 2.5: Decision Enhancement: The fusion of people, process and technology through studios (Source: Keen and Sol 2008)

(Keen and Sol, 2008; Muniafu, 2007). Such a set of integrated tools/technologies is referred to as a suite (Keen and Sol, 2008; Muniafu, 2007). These suites are deployed in a studio using experimental process methods and recipes on how the stakeholders/users can interactively use the deployed suites (Keen and Sol, 2008; Muniafu, 2007). The combination of a suite(s) and a method on leveraging the suite forms a Decision Enhancement Studio (DES). Keen and Sol stress that for stakeholders to work together, they must build shared understanding, which is the biggest advantage of studios.

Decision Enhancement Services may be delivered or achieved through studios in which guidelines to enable various knowledgeable stakeholders to evaluate different "what-if?" scenarios of possible solutions are provided. Such studios are therefore useful in solving problems and may be used in several domains for example, education (Karakaya and Pektas, 2007), hospital clinical care and radiology departments and hospital ward rooms, consulting and after sales services to customers in a software firm and coordination of projects in banking (Van Laere, 2003).

Decision enhancement begins and ends with stakeholders. Its field of practice is a new style of decision process whose goal is to make real and substantial impact for them. It creates a new generation of decision challenges, change and uncertainty, technology and many additional factors and forces (Keen and Sol, 2008). DE is very essential in speeding up process, increasing flexibility in responding to the growing volatility and uncertainties

of the competitive, political, social and economic environment.

2.5 Conclusion

There has been little empirical research and literature relating to IS success in developing countries (Avgerou, 2008; Heeks, 2002). In this chapter, we investigated six useful theories pertaining to IS success. The theory of DeLone and McLean (2002) advanced a useful theory for conceptualizing the main constructs that are important for IS success. However, basing on literature, another three constructs, namely *requirements changes*, *requirements volatility*, and *top management support* were proposed for further exploration as facilitators of IS success in developing countries. The lack of research in developing countries concerning IS success indicates that there is a benefit in carrying out an exploratory analysis of the constructs that lead to successful IS implementations and how these constructs are interrelated. In doing so, the identification of constructs that influence IS success may lead to a list of success constructs that may be used for understanding IS success in developing countries.

3. Understanding IS Success in DCs

3.1 Introduction

In chapter two, we presented a theoretical analysis concerning IS success. We highlighted the importance of investing in new information systems and information systems success in section 2.1. We further explored the relevance of the existing models of IS success to facilitate successful IS implementation in developing countries.

In this chapter, we present activities and results of the initiation phase of our study. Activities in this phase are aimed at informing us on the current IS success environment in Uganda. Using several cases from Uganda as explained in section 3.2, we sought to understand the current IS success in the country, with a view of enabling us design an instrument that will aid in imroving the prospects of achieving successful IS projects.

3.2 Case Selection and Description

We carried out a case study to learn more about IS in developing countries and to determine what factors are important in ensuring IS success. Case study research is the most common qualitative method used to study information systems (Muniafu, 2007; Alavi and Carlson, 1992; Orlikowski and Baroudi, 1991). Yin (2002) defines a case study as an empirical inquiry in which a contemporary phenomenon is investigated within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.

The criteria used to select the case study were:

- A developing country, since we were exploring IS success in developing countries, which led us to choose Uganda.
- Organizations that have multiple stakeholders, which allowed us to get different view points about IS. This also gave us rich feedback about the factors that are important for IS success.

- Organizations that have been using information systems for at least 10 years.
- Organizations that have undertaken systems development in the last 3-5 years. This enabled us carry out assessment of their IS, using knowledge from the stakeholders.

In a developing country like Uganda, a small IS is one with10-30 workstations, a large IS one that has 31-600 workstations and a very large IS is one with more than 600 workstations. A workstation is a high-end microprocessor designed for technical or scientific applications.

Among these were *Bank of Uganda*, *Uganda Telecom Limited*, *Stanbic Bank*, *Uganda Revenue Authority* and *Makerere University Business School*. This selection was based on a list provided by the Faculty of Economics database and the College of Computing and Information Sciences workforce development database; both of Makerere University. Table 3.1 presents the case organizations and their characteristics.

Table 3.1: Case Study Organizations

No	Organization	Type of Business and IS
1	Bank of Uganda	Banking-Large IS
2	Uganda Telecom Limited	Communication-Very Large IS
3	Stanbic Bank Uganda Limited	Banking-Large IS
4	Uganda Revenue Authority	Assessment and collection of taxes-Very Large IS
5	Makerere University Business School	Education-Large IS

Case Description-BOU

The Bank of Uganda (BOU) is the central bank of the Republic of Uganda. Established in 1966, by act of parliament, BOU is 100% owned by the Government of Uganda, but it is not a government department. Bank of Uganda has 4 branches and 5 currency centers situated around the whole country.

With the growth of the bank's activities, it found itself with several isolated legacy information systems, complex user interfaces and technology that was not keeping up with the demands of the bank. Of late, BOU has had to upgrade its existing management information systems.

Case Description-UTL

Uganda Telecom Limited (UTL) is the oldest telecommunications organization in Uganda. The organization was previously a government public company and the only telecommunications provider until the introduction of the liberalization policy that saw new market

entrants. UTL has more than 19 centers in the various towns in Uganda.
UTL was privatized in 2000 and since that time, has embarked on ambitious plans to upgrade their management information systems in billing and telecommunications audit. There have been some fraud cases occasioned by weaknesses in the existing MIS as reported by the CIO.

Case Description-SBU

Stanbic Bank (Uganda) Limited (SBU) is a commercial bank in Uganda. It is one of the commercial banks licensed by Bank of Uganda. The bank is the largest commercial bank in the country by assets, with an estimated asset evaluation of US $ 1.043 billion. SBU also has the largest branch network, accounting for about 16% of the bank branches in the country.
The bank is carrying out an aggressive upgrade of its existing information systems because according to one manager, the bank management information systems simply could not provide the necessary information to fully analyze separate product profitability in the face of stiff competition.

Case Description-URA

The Uganda Revenue Authority (URA) is a body that is vested with assessment and collection of tax revenue for the whole country. Most of the IT infrastructure is at the headquarters of URA in Kampala city. The Uganda Revenue Authority has a number of centers both within Kampala and Uganda. The Uganda Revenue Authority shoulders the responsibility of improving the state of Uganda economy. The mobilization of tax revenue by the Uganda Revenue Authority has the main objective of bettering the condition of life of the people of Uganda. The other goals of Uganda Revenue Authority include reduction in the poverty level of the country, to provide finance for the development activities of current and capital sectors and to increase the ratio of revenue to GNI. The government of Uganda would by this endeavor of Uganda Revenue Authority be capable of providing funds for the essential expenses of the country. As a result, URA has acquired a mammoth ICT infrastructure to cope with the high productivity the market demands. A discussion with the CIO and other managers revealed that the authority is in a pursuit of modernizing its revenue collection efficiency by implementing the latest technology at their headquarters in Kampala and having all the centers connected using fiber-optic links.

Case Description-MUBS

Makerere University Business School (MUBS) is the School of Business of Makerere University, Uganda's oldest University. MUBS is the leading institution in providing business and management education at the certificate, diploma, undergraduate and postgraduate levels.

In a discussion with the CIO, we learnt that the management information systems unit ensures availability and reliability of ICT services in MUBS. To this end, the School is continuously upgrading her systems. There have been documented failures of some information systems that were developed at the School as reported by the CIO. He attributed the failure to technical issues, inexperience in scope and complexity of the challenges of IS, failure to define objectives and lack of communication with top management.

Data Collection

The choice of data sources and data capturing techniques was based on the information needs of this research. We needed information that could inform us of the IS success constructs and the relationship between these constructs. We observed that relevant information should be obtained from the case organizations and their stakeholders. Accordingly, our information sources were information systems managers in these organizations. IS managers provided us with experiences and opinions that pointed to IS success issues. We used an interview schedule which is a form of closed question interview, for the data capture from the field. The interview guide consisted of three main categories of questions. The first part contained background information describing characteristics of the firm and its managers. The second part of the interview guide consisted of various measures of relative performance. Performance was measured on a five-point scale, where the manager was asked to evaluate how important that construct was to information systems success and the relationship between constructs. The third part of the interview guide consisted of three open ended questions that sought to find out from the respondents what other constructs influence the success of their IS, the various appraisal methods used by the manager, and their recommendation on how they would want IS to be assessed. The interview guide was pilot tested using 16 IS lecturers in the Faculty of Computing and Information Technology at Makerere University, as well as 6 IS managers in Kampala. On the basis of the pilot testing it was possible to reduce the questions from 42 to 36. The interview guide is provided in Appendix A.

Respondents Profiles

Out of 40 respondents identified, 31 respondents participated in this study. This represents a response rate of 77.5%. We first wrote to the case organizations, and after permission had been granted, we requested appointments with the CIOs, which were granted. 10 participated for BOU, 5 for UTL, 3 for SBU, 12 for URA and 1 for MUBS. The interviews took place in a number of locations: Gulu in the north of the country; Mbarara and Kasese in the west; Soroti in the east and Kampala. Table 3.2 provides a summary of respondents.

Table 3.2: Respondents' Profiles for each Case

Organization	Respondents	Number
BOU	First Line Manager	6
	Middle Level Manager	3
	Executive Level Manager	1
UTL	First Line Manager	1
	Middle Level Manager	3
	Executive Level Manager	1
SBU	First Line Manager	1
	Middle Level Manager	1
	Executive Level Manager	1
URA	First Line Manager	4
	Middle Level Manager	6
	Executive Level Manager	2
MUBS	Executive Level Manager	1

3.3 Case Study Results

The variables that were tested in the case study come from chapter 2 where they were extensively defined. The case study results are presented below:

Biodata

The personal information about the IS managers was obtained through interviews with 31 IS managers from Kampala, Gulu, Soroti, Mbarara and Kasese in Uganda. More than 61% of the managers were operational managers, and more than 35% were middle level managers. At least 3% were top level managers. More than 76% of the managers had worked at their current position for a period exceeding 3 years, implying that they were knowledgeable in what they were doing. Table 3.3 shows the information about these managers.

Table 3.3: Personal Information

Personal Information		
Variable	Category	Percentage
Current Position	First Line Manager	61.3%
	Mid-level manager	35.5%
	Executive	3.2%
Length of time as IS Manager	Under 1 year	16.1%
	1-2 years	6.5%
	3-6 years	29%
	6-10 years	29%
	10 years+	19.4%

How Requirements Affect IS

Respondents' knowledge of how requirements affect an information system and hence its success based on their opinions about requirements volatility, information quality and the importance of user training is illustrated in Table 3.4.

Table 3.4: Requirements

Requirements		
Variable	Response	Percentage
Quality requirements affect IS	Neutral	3.2%
	Agree	35.5%
	Highly agree	61.3%
Quality requirements result into improved system quality	Agree	32.3%
	Highly agree	67.7%
Quality requirements provide quality info to decision makers	Highly disagree	3.2%
	Neutral	12.9%
	Agree	42%
	Highly agree	41.9%
Modifications are being made to the IS over the system life cycle	Highly disagree	3.2%
	Disagree	6.5%
	Neutral	12.9%
	Agree	58%
	Highly agree	19.4%
Frequent changes in requirements reduce system quality	Disagree	25.8%
	Neutral	22.6%
	Agree	25.8%
	Highly agree	25.8%
Requirements changes affect the quality of information	Disagree	35.5%
	Neutral	9.7%
	Agree	38.7%
	Highly agree	16.1%

Requirements always change, but if the changes are too great, then we end up with a less than optimal information system. As seen from the responses in Table 3.4, 77.5% of respondents attest that there were continuous modifications made to the IS, which illustrates changes in requirements. 83.9% of the respondents acknowledge that quality requirements are a requisite for improved decision-making, thus requirements need to be

handled well.

Information Quality

Respondents' knowledge of how information quality influences decision making, user satisfaction and systems use was assessed based on their opinions about decision making, user satisfaction and information inadequacy as illustrated in Table 3.5.

Table 3.5: Information Quality

Information Quality		
Variable	Category	Percentage
Information quality influences decision making	Neutral	9.7%
	Agree	48.4%
	Highly agree	41.9%
Information quality affects user satisfaction	Disagree	6.5%
	Neutral	12.5%
	Agree	41.9%
	Highly agree	38.7%
Information inadequacy leads to less systems use	Highly disagree	6.5%
	Disagree	6.5%
	Neutral	12.9%
	Agree	48.4%
	Highly agree	25.8%

The results indicate that information quality derived from an information system is very important for decision-making, systems use and user satisfaction. It follows that when the level of information quality is low, there would as a consequence, be less user satisfaction and less systems use.

System Quality

Respondents knowledge of how system quality improves information quality, user satisfaction and how service quality from IT support can improve job performance was assessed as illustrated in Table 3.6.

The results indicate that when the system quality is high, more stakeholders will be encouraged to use the system in addition to increasing user satisfaction.

Table 3.6: System Quality

System Quality		
Variable	Category	Percentage
Higher system quality leads to improved info quality	Highly disagree	3.2%
	Disagree	12.9%
	Neutral	38.7%
	Agree	29%
	Highly agree	32.3%
Higher system quality leads to increased user satisfaction	Disagree	3.2%
	Neutral	22.6%
	Agree	35.5%
	Highly agree	32.3%
The higher the system quality, the more the system is used	Highly disagree	3.2%
	Disagree	6.5%
	Neutral	12.9%
	Agree	48.4%
	Highly agree	25.8%

Service Quality

Respondents knowledge of how requirements affect service quality, and how improved service quality from the IT personnel enhances user satisfaction and job performance was assessed as illustrated in Table 3.7.

Table 3.7: Service Quality

Service Quality		
Variable	Category	Percentage
Requirements changes affect the service quality (SVC)	Disagree	6.5%
	Neutral	12.5%
	Agree	48.4%
	Highly agree	32.3%
Improved service quality from IT personnel enhances user satisfaction	Highly disagree	3.2%
	Disagree	3.2%
	Agree	41.9%
	Highly agree	51.6%
Improved service quality from IT personnel improves job performance	Disagree	3.2%
	Neutral	9.7%
	Agree	48.4%
	Highly agree	38.7%

Results from the study confirm that improved service quality from IT personnel enhances user satisfaction and improves job performance.

Systems Use

Respondents knowledge of how using the IS increases productivity, and how information inadequacy leads to less systems use, was assessed as illustrated in Table 3.8.

Table 3.8: Systems Use

Systems Use		
Variable	Category	Percentage
Higher system quality leads to improved information quality	Highly disagree	3.2%
	Disagree	9.7%
	Neutral	25.8%
	Agree	29%
	Highly agree	32.3%
Higher system quality leads to increased user satisfaction	Disagree	9.7%
	Neutral	22.6%
	Agree	35.5%
	Highly agree	32.3%
The higher the system quality, the more the system is used	Highly disagree	3.2%
	Disagree	6.5%
	Neutral	32.3%
	Agree	35.5%
	Highly agree	22.6%
Using the IS increases productivity	Neutral	12.9%
	Agree	61.3%
	Highly agree	25.8%
Information inadequacy leads to less systems use	Highly disagree	6.5%
	Disagree	6.5%
	Neutral	12.9%
	Agree	48.4%
	Highly agree	25.8%

The results suggest that higher system quality leads to increased use of the system, that will result into increased user satisfaction.

User Satisfaction

Respondents knowledge of how user satisfaction leads to higher IS usage, better requirements and meeting of user expectations was assessed as illustrated in Table 3.9

The results indicate that increased user satisfaction leads to higher usage of information systems, which is a net benefit. In addition, when the IS meets the expectations of its users, user satisfaction is increased.

Table 3.9: User Satisfaction

User Satisfaction		
Variable	Category	Percentage
Greater user satisfaction leads to higher IS usage	Disagree	3.2%
	Neutral	16.1%
	Agree	38.7%
	Highly agree	41.9%
Higher system quality leads to increased user satisfaction	Disagree	9.7%
	Neutral	22.6%
	Agree	35.5%
	Highly agree	32.3%
Higher user satisfaction results in better quality requirements	Disagree	16.1%
	Neutral	29%
	Agree	41.9%
	Highly agree	12.9%
By the IS meeting expectations of users, satisfaction is increased	Neutral	6.5%
	Agree	54.8%
	Highly agree	38.7%

Net Benefits

Respondents knowledge of how net benefits from IS can be derived was assessed as illustrated in Table 3.10.

Table 3.10: Net Benefits

Net Benefits		
Variable	Category	Percentage
Improved quality of work done is a net benefit	Neutral	16.1%
	Agree	54.8%
	Highly agree	29.0%
One of the net benefits of IS is it makes it easier to work	Neutral	6.5%
	Agree	61.3%
	Highly agree	32.3%
Having greater control over one's work is a net benefit	Highly disagree	3.2%
	Disagree	9.7%
	Neutral	25.8%
	Agree	41.9%
	Highly agree	22.6%

The results show that improved quality of work, the making of work easier by use of IS and having greater control over one's work are some of the net benefits derived from an information system.

Top Management Support

Respondents knowledge of how top management support is instrumental in deriving quality requirements, user satisfaction and leads to better service quality was assessed as illustrated in Table 3.11.

The results indicate that top management support is very crucial in deriving quality requirements for an information system, results into improved user satisfaction and leads

Table 3.11: Top Management Support

Top Management Support		
Variable	Category	Percentage
Top mgt support is crucial in deriving quality requirements	Highly disagree	3.2%
	Disagree	6.5%
	Neutral	16.1%
	Agree	35.5%
	Highly agree	38.7%
Top mgt support leads to higher user satisfaction	Highly disagree	3.2%
	Disagree	16.1%
	Neutral	22.6%
	Agree	32.3%
	Highly agree	25.8%
Top mgt support leads to better service quality	Neutral	12.9%
	Agree	51.6%
	Highly agree	36.5%

to better service quality form the IT personnel.

In addition to the closed questions above, there were 3 open-ended questions that sought opinions of respondents about the success of their IS, their knowledge and application of methods used to assess IS and what they would recommend to improve IS assessment? The questions and answers are documented in Appendix G.
Table 3.12 lists the IS assessment methods, a brief explanation and their justification for inclusion in the study as well as the respondents that had used them.

Table 3.12: IS Assessment Methods in Use

IS Assessment Methods			
Method	**Characteristic**	**Responses**	**Reference**
Pay Back Method	Financial	2	Renkema and Bergout (1997)
Accounting Rate of Return	Financial	4	Renkema and Berghout (1997)
Cost Based ratio	Financial	2	Fitzgerald (1998)
Strategic Cost Management	Financial	1	Hallikainen *et al.,* (2002)
Return on Investment	Financial	2	Fitzgerald (1998)
Internal Rate of Return	Financial	2	Berghout (1997)
Discounted Cash Flow	Financial	2	Berghout (1997)
Net Present Value	Financial	4	Renkema and Berghout (1997)
Balanced Score Card	Multi-criteria	6	Rohm (2008)
Profitability Index	Financial	1	Olawale *et al.,* (2010)

Most of the respondents as seen in Table 3.12, were of the view that most of the current methods used to assess IS are financial and were thus not very useful in assessing IS success. In addition, there are a number of elements that are invisible and intangible like employee morale, that cannot be measured by the current appraisal methods. Many respondents reported that no formal assessment is ever carried out in their organizations, but even for the few respondents who acknowledged some form of assessment having been carried out in their organizations; they complained that no meaningful assessment has ever been carried out. They blamed this on a number of issues ranging from:
-Organizational culture where the boss has to be obeyed without question.
-Being side-lined on decisions concerning IS.
-Internal politics that sometimes leads to poor decision-making.
-Lack of management support occasioned by lack of knowledge on the part of management and many others.

The respondents felt that a solution that would support them in assessing IS success, where all stakeholders are involved would be beneficial. We thus need a solution to solve the needs of stakeholders to improve the prospects of IS success in developing countries.

3.4 Resulting Conceptual Model

The results from the exploratory study confirmed the importance of the constructs in the DeLone and McLean (2002) theory to IS success, however, it was also revealed that for a developing country context, another three facilitating constructs were needed to ensure success. These were *requirements changes*, *requirements volatility* and *top management support*. It was also revealed that while user satisfaction has a direct relationship with information quality, service quality and system quality in the DeLone and McLean (2002) theory, results indicate that user satisfaction has an indirect relationship with these constructs through systems use. The argument of respondents was that you cannot register user satisfaction without users having used the system.

In a follow-up of the exploratory study, we compared the case study results with the original DeLone and McLean model shown in Figure 2.2. The constructs *information quality, service quality, system quality, systems use, user satisfaction* and *net benefits* are derived from DeLone and McLean (2002). *Requirements changes* and *requirements volatility* are derived from Henderson (2006), Nurmuliani (2006) and Williams 92003). We had a round table discusiion with IS managers from URA in order to come up with the conceptual model in its present form as seen in figure 3.1.

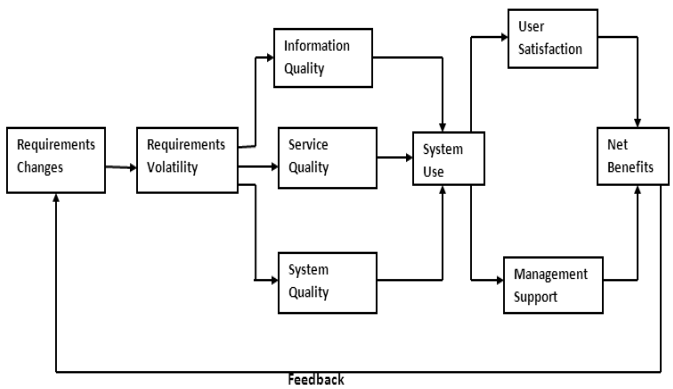


Figure 3.1: The Resulting Conceptual Model

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In the figure, it is observed that Requirements Changes lead to Requirements Volatility which in turn reduces Information Quality, Service Quality and System Quality. These three in turn affect System Use; unlike in the DeLone and McLean model where they affect both System Use and User Satisfaction. In the model, System Use acts as an intervening construct, meaning that increased System Use is posited to increase User Satisfaction as well as Management Support.

The conceptual model was converted into a global influence diagram. The global influence diagram helps us to understand further, the basics of IS success. It also reveals the need to adapt the DeLone and McLean (2002) theory to developing countries. The model as presented in Figure 3.1, is a conceptual model indicating relationships. In order for it to be useful in testing these relationships, we have to translate the constituent constructs into precise measurable variables. One step is to use influence diagrams at a more detailed level.

In this research, we propose to use a System Dynamics representation (Semwanga, 2009; Sterman, 2000), for converting the conceptual model into a global influence diagram with positive and negative feedback loops as shown in Figure 3.2.

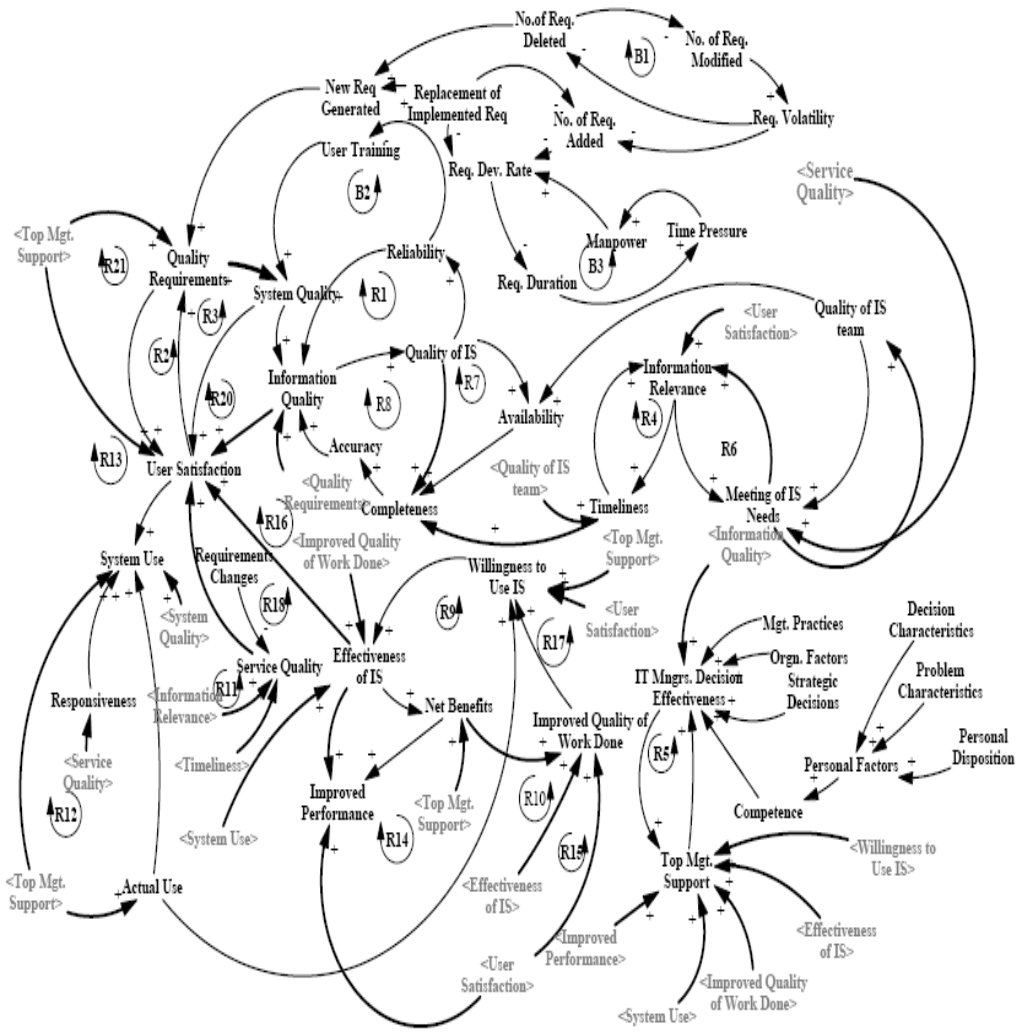

Figure 3.2: The Global Influence Diagram with Feedback Loops

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3.5 Consistency Check

"A model is a simplified representation of a complex system or a process developed for its understanding, control and prediction; it resembles the target system in some respects while it differs in other respects that are not considered essential" (Dodig-Crnkovic, 2008). In doing this, we must ensure that the model equations are technically correct, even to the extent of checking that (+) has not been used when (-) was required (Dodig-Crnkovic, 2008; Irobi *et al.,* 2004; Maani and Cavana, 2003; Coyle, 2000; Coyle and Exelby, 2000; Barlas, 1996; Coyle, 1977).

The behavior of a model should be carefully checked as serious model defects will usually expose themselves through some failure of the model to perform as would be expexted of the real system. Improvements must be made only if they represent the real system, not because they resolve the problem (Coyle and Exelby, 2000). Every sub-model and the overall model must be evaluated to determine if they are reasonable and correct for the intended purpose of the model (Sargent, 2007; Martis, 2006; Qudrat-Ullah, 2005).
A model can be said to explain the behavior of a system if it reflects the real causal relations of the system. Consequently, the extent to which the model is useful is more the function of the user than the modeler/developer (Humberto *et al.,* 2006).

Checking of the Influence Diagram for Correctness and Completeness

A questionnaire to assess the global influence diagram, attached as Appendix B, was designed with the following objectives:
i.To test for clarity: the extent to which the model clearly captures and communicates issues concerned with information systems success.
ii.To test the existence of the variables that are shown in the model.
iii.To test whether the relationships between variables in the model have been clearly represented.
Five questions were included in the questionnaire. The first question sought answers as to whether all the variables stated in the influence model existed in the information systems success environment. The second question sought answers as to whether the relationships between the variables exist in practice. The third question sought answers as to whether any significant factors were missing and if so, the respondent was requested to list them. The fourth question sought answers as to whether the directions of the links were correct or that they needed to be reversed. The last question sought answers as to what other

effects could be observed as a result of the documented cause in the dynamic model. Maani and Cavana (2003) state that before a model can be used, management must have sufficient confidence in the soundness and usefulness of the model. Confidence in the model accumulates gradually as the model passes more tests and is more comparable to reality.

Our global influence diagram was presented to experts for consistency checking. These experts, 12 in number, were drawn from Uganda Revenue Authority (URA) (see Table 3.2). Table 3.13, presents the profiles of these experts. The reason why we selected URA is that URA has more than 40 IS managers with vast average experience of more than 5 years. The organization has undertaken comprehensive system development in the last 5 years which cover the entire country and has more than 600 workstations.

Table 3.13: Categories of IS Managers Acting as Experts

Level	**Number**
First Level Manager	4
Middle Level Manager	6
Executive Level Manager	2

By taking users through the influence diagram and the resultant explanations, they came to appreciate that this diagram helped them to understand what was going on in the organization and to the IS. Another advantage of the influence diagram was that users, irrespective of their rank or hierarchy in the organization were able to contribute to the debate, thus allowing collaboration and in the process generating more insight. At the same time, users get committed to the decisions that are arrived at collaboratively, thus enabling them make better decisions. The realization that better alternatives are possible motivates people to change.

Results of Consistency Checks with Experts

Experts assessed how close the influence diagram was to the real system. It involved asking individuals knowledgeable about information systems whether the influence diagram and/or its behavior are reasonable. For example, is the logic in the influence diagram correct and are the input-output relationships reasonable (Sargent, 2007; Martis, 2006). We used this as face validation of our influence diagram. Their feedback was positive and we thus adopted the influence diagram.

A summary of their feedback is presented in Table 3.14

Table 3.14: Consistency Check of the Global Influence Diagram

Statement	Response	Score	Statement	Score	Statement	Score
In your opinion, how do you rate this influence diagram?	Very Reasonable	7	Reasonable	3	Fairly Reasonable	2
How good is the influence diagram at representing issues about IS success	Very Good	7	Good	5	Fairly Good	0
How good is the influence diagram at communicating issues concerning IS success	Very Good	2	Good	10	Fairly Good	0
How do you rate the influence diagram as an aid for understanding IS success?	Very Useful	8	Useful	3	Fairly Useful	1

From the results presented in Table 3.14, the global influence diagram was rated by IS managers as very realistic in representing IS success issues, and was deemed very useful in helping them understand IS success issues in developing countries.

The extended theory was checked by experts and they felt it was useful for analyzing IS success in developing countries. In summary, the extended theory is comprised of the original IS success constructs from Delone and McLean (2002) as well as three facilitating constructs namely *requirements changes*, *requirements volatility* and *top management support*.

3.6 Considerations for Enhancing IS Assessment

From the presented results in the exploratory study, we noted the following aspects. The IS respondents revealed that they face challenges as evidenced in section 3.3. The implications of the exploratory study revealed that solutions developed could provide support to improve IS success. In this research, we state that IS implementation can be improved by providing solutions that address the challenges. There are many ideas of a solution for IS assessment in relation to IS success, but the challenge as observed from the exploratory study is that many of them are financially based, complex to use and do not take into account the challenges identified. Some of these challenges are lack of top management support, lack of involvement of IS stakeholders, lack of a clear process for IS assessment to mention but a few. Therefore, there is potential for an appropriate approach. Keen and Sol (2008) argue that the companies that use decision support tools like simulation

models for their decision making have a competitive advantage over those that do not.

Based on the exploratory study, we state that in designing a solution for IS success assessment, two items need to be considered namely: providing an easy to use IS assessment solution, and the IS assessment process improvement. This is because complexity is one of the challenges quoted by respondents as preventing the known methods from being utilized and the IS assessment process being unclear to the majority of the stakeholders.

Providing an IS Assessment Support Environment

The exploratory study demonstrated that there exist very many complex methods for assessing IS and that this led to confusion and misunderstandings. Another challenge that featured very much was lack of involvement of stakeholders in IS assessment, sometimes leaving this vital task to non-IS executives. The desire for a single, simple to use and readily understood solution for assessment of IS was cited as important and was presented by the majority of respondents when asked about the assessment method that was being used in a given organization. The IS assessment process is complex because it deals with multiple stakeholders who include: novice users, IT strategy and planning, business analysts, accountants, IS managers, IT application developers, systems managers, research and development, software engineers, business analysts, systems analysts, security administrators, desktop support, and top management. A general finding from the exploratory study reveals that the availability of an IS assessment solution is desirable. Without a simple to use and universally accepted method, IS assessment is likely to remain complicated and to a certain extent, not attempted at all.

Requirements for a Solution for Improving the Prospects of IS Success

The section below describes the IS assessment improvement considerations (please refer to section 3.3 and Appendix A Qns 35 and 36):

1. Limited knowledge and appreciation of IS assessment: Some of the respondents did not know about assessment of IS and those that did, did not have a standard way of assessing IS. Given the multiple stakeholders, and variety of IS, the IS assessment solution should be easy to use.

2. Provision of training to stakeholders: Many of the respondents were of the opinion that all stakeholders involved in assessment of IS should be involved in the IS assessment. In order for stakeholders to have a common understanding so as to work together, appreciate IS success and the IS success assessment process, training should be availed to all stakeholders to be involved in the IS assessment process. A solution to enable stakeholders

appreciate IS success is desirable.

3. Enable all stakeholders participate in the IS assessment process: Many respondents complained of being left out. A solution to enable them share IS assessment insights through communication is desirable.

4. Enable addition or removal of new modules: All the stakeholders stated that requirements keep changing over the life-cycle of the information system. The users could add or remove modules in order to be able to adapt to their ever changing needs and those of the information systems.

5. Holistic services: The major components involved in the IS assessment process are people, process and technology. There is need for stakeholder involvement in the IS assessment processes. This is vital, since the stakeholders involved have differing interests and opinions. To improve the IS assessment process, we need all the stakeholders to share the same information and understanding of the problem of IS success.

6. Enable a well organized IS assessment process: All participants were emphatic that there is no meaningful IS assessment taking place in their organizations. A solution that enables stakeholders assess their IS is desirable.

Given the findings and challenges in the previous section, there is a case for developing an IS assessment solution that meets respondents needs. The IS assessment solution would be used in improving IS assessment processes within organizations. The use of ICT to enable IS assessment services is expected to bridge the gap between the problems and constraints observed in the exploratory study. The IS assessment process could be improved by providing a systematic approach to IS assessment through the provision of an IS assessment solution that is acceptable and well understood by all stakeholders.

4. An Instrument for Predicting IS Success

4.1 Design Approach

A design approach is commonly understood to be a coherent set of activities, guidelines and techniques that can structure, guide and improve a design process. Design approaches can be evaluated by their underlying *way of thinking*, *way of controlling*, *way of working* and *way of modeling* (Van de Kar, 2004; Sol, 1988). The way of thinking of an approach expresses the underlying philosophy. The way of controlling expresses the managerial aspects of the design approach. The way of working articulates the possible compound tasks which must be performed to carry out a design process. The way of modeling refers to the modeling tasks and concepts suitable for modeling relevant aspects of the problem situation (Van de Kar, 2004; Sol, 1988).

Instead of describing a design approach, we are using the framework to articulate our solution, where we depart from the literature reviewed and the exploratory case study.

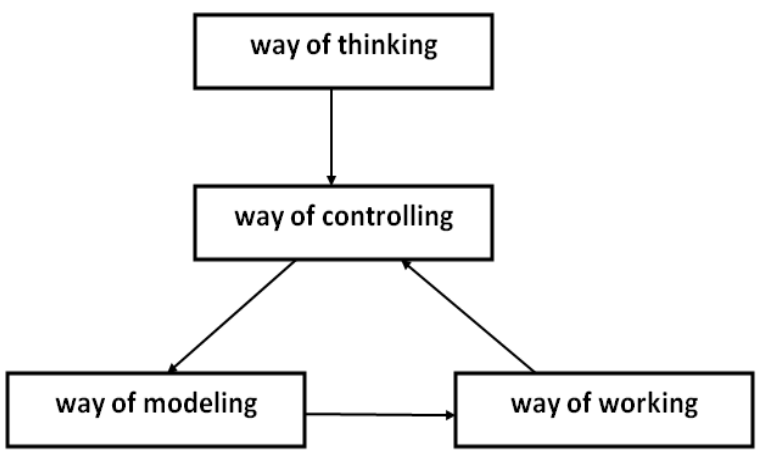

Figure 4.1: A Framework for Understanding Design Approaches [Based on Sol, 1988]

4.2 Way of Thinking

The way of thinking of an approach expresses the underlying philosophy that is used in the approach (Van de Kar, 2004). The way of thinking describes how we observe organizations, information systems and how these are implemented. It portrays the concepts and theoretical foundations for services to enhance IS assessment. In order to resolve the IS assessment issues, Keen and Sol (2008) suggest structuring the IS assessment process by using appropriate technology and involving different actors.

The three major perspectives for IS assessment are based on an interaction of people, technology and process.
The people aspect refers to the actors involved in IS assessment process. People make decisions, their skills, values, judgment and experience shape the decision (Keen and Sol, 2008). The actors involved in the IS assessment process are: top management, novice users, system administrators, programmers, system developers, systems analysts, accountants, IS managers and IT application developers.
Technology provides the services necessary to realize the IS assessment process.
The processes refer to the IS assessment decision processes which influence the actors to make effective decisions.

The way of thinking is to provide an IS assessment instrument as a Decision Enhancement Studio (Keen and Sol, 2008). A studio has been defined by Keen and Sol (2008) as an environment or shared space or forum, which contains a set of integrated tools/technologies (suite) that enable stakeholders (people) to interactively collaborate to generate and analyze 'what-if' scenarios of the possible solutions to a given problem. The suite pulls towards the technical, analytic and routinized, while the studio pulls towards the social and interpersonal. The studio enables fusion between technologies required to provide for functionalities and the people involved in the decision process. There are three types of studios, namely: learning, inquiry and participatory.

Learning studios aim at providing the participants with an environment to build an in-depth understanding of concepts, leading to a new sense of options and process. These types of studios are very useful where the complexity of the work environment leads to specialized skills and roles, with a constant challenge of how to fit the different pieces together. Examples are given of hospital clinical care and radiology departments and

hospital ward rooms, consulting and after sales services to customers in a software firm and coordination of projects in banking (Van Laere, 2003).

Inquiry studios are more prescriptive in their focus and style. The goal is to foster critical inquiry, challenge assumptions and seek out original directions for the process.

Lastly, the participatory studios are much more invitational and aim at encouraging the involvement of participants in the process that is most likely to lead to consensus, agreement and commitment.

The IS assessment instrument as proposed can be seen as a single suite with three modes: training, communication and assessment modes. The instrument works as a decision enhancement suite and uses a simple visual interface for displaying the results of simulation experiments by use of graphical output. The suite creates a unique environment where diverse stakeholders are engaged at a common point (say a conference or boardroom) where they discuss and build an in-depth understanding of the issues; they then go on to test their assumptions using simulation experiments. The instrument consists of sophisticated computer programs that can make changes to a process within an artificial environment. It can thus be used to explore and gain insights into IS success issues and to estimate when a particular IS can be deemed successful and why. The instrument uses simulation modeling and is easy to use. Once the dynamic behavior is understood by the user, changes to the system can be made or controls can be designed via input variables accessible to the user.

The suite makes it possible to access the simulation models via the interface. In this way, the suite encourages involvement that leads to commitment rather than avoidance that leads to delay and in some cases a purely "political" decision imposed by a subset of stakeholders (Keen and Sol, 2008). The suite is participatory in nature in that the information and display tools make participation easy and effective. A pc or laptop and a projector are used to display the outputs to a large group of attendees. The members who may not have attended the session may share the same information by having the simulation results uploaded on the web.

A Decision Enhancement Studio (DES) has four settings of communication (Keen and Sol, 2008): same time-same place; same time-different place; different time-same place

and different time-different place. In this research, two settings were selected, that is, same time-same place using a laptop and overhead projector as well as different time-different place using laptops and Internet.

In light of the need to carry out experiments in order to test the understanding of stakeholders IS success issues as well as review IS performance using simulation, again a participatory style of the studio, including guidelines for its use, was selected for the IS assessment instrument.

4.3 Way of Controlling

The way of controlling describes measures and methods for using the IS assessment instrument. When considering supporting decision makers in a multi-actor environment, the following have to be observed:

1. It is important that only those actors that have the time and commitment are involved. Preparing for participation is an important aspect for the IS assessment process, because the eventual success of the whole process heavily depends on it.

2. All stakeholders need to be encouraged to participate in the IS assessment process. For the results to be meaningful and useful, as many stakeholders as possible need to be involved. By working collaboratively, a better picture of the IS will be realized. By proper representation, a higher degree of commitment is also ensured.

3. The participants should all be given a training run on IS success issues and on the IS assessment instrument. Those using the instrument should have the necessary experience and skills. This translates into being able to interpret the results obtained and deciding how to use these results for improving IS implementations.

4. Flexibility: Not all information systems are similar. Variables that are key in one information system may not be the ones in another. The IS assessment instrument should be flexible to allow stakeholders add variables that may be necessary for IS assessment for their selected IS.

5. Differing viewpoints: The stakeholders should be able to select the variables that they consider key to their IS and run their own simulation experiments. Due to various actors involved, there are normally many viewpoints. By stakeholders setting their own experiments, stakeholders gain and share more insight.

6. Feedback: The stakeholders should be able to use the graphical user interface and tables in unison to give a comprehensive picture of the results. Feedback is a very important aspect for learning and decision-making. This is especially important since the

stakeholders are working collaboratively as a group. In addition to this, interpreting results requires a meaningful picture of the results.

7. Working with the instrument: Many stakeholders when faced with a new learning environment are apprehensive and would rather observe than fully participate. There is thus a need to allay their fears so that they become active rather than passive participants. There should be a feature for reversing a user's action in case of an error to enable greater participation.

8. Decision making: Assessment is normally used for improvement from the current situation. The stakeholders involved in the assessment exercise should pool their ideas and insights gained from using the instrument for a constructive dialogue to enable them reach a common decision. This will help them effect changes to those areas of IS implementation that are found lacking.

4.4 Way of Working

The way of working specifies the steps that are followed in using the instrument. Following the way of thinking described in section 4.2, and considering the derived requirements in chapter 3, 3 modes were identified to provide the required functionality of the instrument. The three modes are training, communication and assessment of IS.

Training mode

The training mode supports the stakeholders to gain a common understanding on the issues that affect IS success. They will then better be able to understand the results presented to them by the instrument and thus be abe to make informed decisions about their IS based on these results. Training, in its simplest form is an activity that changes people's behavior. Increased productivity is often said to be the most important reason for training. Training is transferring information to organization's members to positively improve the effectiveness and productivity of organizations. Training enables organizations to act more effectively because of having valued employees. It creates the professional development and enhances the employee's skills. It also makes knowledgeable workforce with fewer mistakes. (Mehrabani and Mohamad, 2011). In the training mode, skilled users of the instrument impart knowledge to less skilled users, set up experiments, and through observing the outputs of these experiments, the learner gets more insight concerning IS.

Below is given an outline of the steps taken in training. It is used to get managers/users

acquainted with the instrument as well as create understanding about what constitutes IS success, and how it can be achieved.
This session involves the following steps:

- Introduction of the instrument
- Introduction of the user manual
- Users open the training screen
- Users select variables they want to experiment with on the graph as well as table pads
- Users set the simulation run modes
- Users run experiments
- Users observe the behavior of the variables over time

Communication mode

The communication mode enables stakeholders who have participated in an assessment exercise to publish the resulting simulation experiments to the Web. The simulation results are first exported for NETSIM (®) and saved as a .TXM file. The simulation results are then uploaded as a .TXM file. In the third step, the results are then published to the Web using one of two methods:
1. Publishing to the Web using the ISSEE Website using
Proxy URL::myproxy.isseesystems.com:4400.
2. Publishing to the Web using a server located in the organization, for example Proxy URL::10.10.0.160
In this way, those interested in viewing these results are able to download the file and view the contents at any location, provided they are connected to the Internet.

The steps taken in the communication mode are illustrated below. It is used to share insights by users concerning experiments they were able to run separately.

- Users open the communication screen
- Users are guided through experiments that had already been set up by researcher
- Users make observations after the experiments are explained

- Users select variables they want to experiment with
- Users run experiments
- Users observe the behavior of the variables over time
- Users now share the insights gained with their fellow users and the researcher
- Users save file as *.TXM
- Users open isee NetSim for publishing the file to the Web and then publish it

Assessment mode

The assessment mode facilitates the review of a selected IS using simulation experiments. It allows the participants select the variables that they feel are key for this particular IS, agree on their values, set the values and run simulation experiments. Based on the results of the simulation experiments and the understanding gained, the stakeholders can then come to a decision about what actions to take on that particular IS. Users first experiment by setting different values for the instrument variables and running simulation experiments. They keep on changing the values and running the simulation experiments while sharing insights. Through open discussion, the users agree on the different values of the input variables which they believe represent their particular IS with reasons why they apportion those values. These could be from user reports or from the knowledge of the system by users or managers. These values and the reasons are documented in a table. Simulation experiments are then run and observations made about the results. The results are then discussed with a view of coming up with recommendations to management about the assessed IS.

The steps taken for assessment of an information system are illustrated below. These are the steps used to assess the IS identified by the participants. Information and data from assessment informs IS managers about the IS and about user perceptions concerning the IS. The information collected can be used in planning and carrying out particular interventions to improve the situation. During the assessment process, the IS manager gains insight in what drives a successful IS. By knowing which variables are important and what actions are necessary to ensure IS success, this leads to IS managers making better decisions.

It is recommended that at the implementation of a new IS, the manager needs to do an initial assessment. This will provide entry data and a baseline to use for the lifetime of the IS. The purpose of an initial assessment is to get a snapshot of the IS at the start. This session involves the following steps:

- Users open the assessment screen
- Users first experiment by setting different values for the input variables and running simulations. They keep on changing the values and running simulations, while sharing insights
- Users, through consensus, agree on the different values of the input variables which they believe represent their particular IS, with reasons. These could be from user reports or from the knowledge of the system by the users and managers.
- The values of the variables are then documented in a table
- By using buttons and sliders, users set the values of the input variables from the table drawn above
- Users run experiments
- Users observe the behavior of the output variables for assessment over time
- Users save a copy of the results as evidence of assessment at that particular time
- Users now share the insights gained with their fellow users and the researcher

4.5 Way of Modeling

The way of modeling identifies the modeling tasks and the use of modeling concepts that are suitable for modeling relevant aspects of the problem situation (Van de Kar, 2004; Sol, 1982). In modeling, diagramming techniques are often used as the initial grammar for representing and visualizing a system. In our way of modeling, the global influence diagram presented in Figure 3.2 is decomposed into detailed influence diagrams.

We adopted System Dynamics to enable dynamic analysis of the influence diagrams as System Dynamics is an approach to understanding the behavior of complex systems over time (Semwanga, 2009; Sterman, 2000; Forrester, 1961). It deals with internal feedback loops and time delays that affect the behavior of the entire system. The basis of the

method is the recognition that the structure of any system, that is the many circular, interlocking, sometimes time-delayed relationships among its components is often just as important in determining its behavior as the individual components themselves. What makes using System Dynamics different from other approaches to studying complex systems is the use of feedback loops and stocks and flows. These elements help describe how even seemingly simple systems display baffling nonlinearity (Sterman, 2000). It is widely used to analyze a range of systems in, for example, business, ecology and social systems as well as engineering (Azar, 2012). The approach focuses on the way one quantity affects others through the flow of physical entities and information. Often such flows come back to the original quantity causing a feedback loop. The behavior of the system is governed by these feedback loops (Semwanga, 2009; Sterman, 2000; Forrester, 1961; Richardson and Pugh, 1981).

There are two important advantages of taking a System Dynamics approach. The interrelationship of the different variables of the system can easily be seen in terms of cause and effects. Thus the true cause of the behavior can be identified. The other advantage is that it is possible to investigate which variables need to be changed in order to improve behavior. As an alternative, System Dynamics can give significant insights without having to use mathematical methods (Azar, 2012; Forrester, 1961).

System Dynamics is a computer simulation modeling technique for framing, understanding, and discussing complex systems and problems. The goal of system dynamics modeling is to improve our understanding of the ways in which an organizations performance is related to its internal structure and operating policies, including those of customers, competitors, and suppliers and then to use that understanding to design interventions for success. It allows us to construct simulations of our mental models "virtual worlds" - where space and time can be compressed and slowed so we can experience the long-term side effects of decisions, speed learning, develop our understanding of complex systems, and design structures and strategies for greater success (Semwanga, 2009; Sterman, 2000).

There are four basic building blocks used in a system dynamics model: stocks, flows, connectors and converters. Stocks are fundamental to a system and represent the basic variables, or quantities that change in a system. For example in a population model, one stock may represent the population of the country. Flows represent rates and determine what goes in or comes out of a stock. These could be representing physical or informa-

tion flows. Converters hold information and can themselves vary because they depend directly or indirectly on stocks. This is because converters represent either fixed quantities (constants) or represent variable quantities which are derived from other quantities (Semwanga, 2009; Sterman, 2000).

The combination of these building blocks is a dynamic system because the stocks, flows and converters may change over time. The dynamic system can be simulated using appropriate software (Semwanga, 2009).

When a System Dynamics model is constructed from an influence diagram, the modeler determines which of the variables in the influence diagram should form the stocks and flows in the System Dynamics model, then uses the rest of the influence diagram to determine the main relationships that should be included in the System Dynamics model (Howick *et al.,* 2009).
A number of guidelines (Blanco, 2010), are always followed in doing so as illustrated below:
1. To identify which stock(s) to include, first identify the critical behaviors of the system. Using loops identified in the influence diagram, target those loops that reflect those behaviors. When choosing a name for any element in a stock/flow diagram, keep comparative words such as more or less out of the name, for example, Level of Stress is preferable to More Stress. Labeling parts of the diagram clearly is critically important. The labels make the story clear to others.
2. The flows physically connect with the stocks and control the amount of stuff in each stock. The rates of flow through the model must be set and remain consistent through.
3. Converters contain information that, ultimately, affects the flows that affect the stocks. Work outward from the flows in identifying those converters. What converter(s) will affect each flow? What converter(s) will affect those original converters?
4. Once the stock(s), flows, converters, and connectors have been drawn, a check is carried out to identify the feedback from the stock(s) that makes a system dynamic. Ask questions such as: Does the accumulation in the stock affect its inflow? outflow? converters? other stocks inflow/outflow/converters?

Variables Used

We have four types of variables that are used:

1. **State Variables**

State variables, for example the numbers of trainees in a training system, describe the resource status at any given point of time during the information process. These change continuously with time (Seila *et al.,* 2003). SD refers to state variables as levels or stocks. Levels/stocks are observable and measurable, and their patterns of change over time completely define the system dynamical behavior (Pidd, 2003). The initial states for all stocks are all zero and can never be negative. these are presented in the startup conditions in chapter 5. As observed earlier, stocks are fundamental to a system since they represent those quantities that change in a system (Semwanga, 2009).

2. **Rate or Flow Variables**

In SD, levels will rise and fall by inflows and outflows. The inflows and outflows are referred to as rate or flow variables, which are the driving forces of the dynamics of the system (Pidd, 2003).

3. **Input Variables**

Input variables, are variables that are determined by factors outside the scope of the system. When some factor is believed to influence the system from outside without being influenced itself, it is represented as an exogenous variable in the model. Some of these are manipulated by the decision makers and are then called decision variables (Pidd, 2003). By simulation the decision makers see the probable effects of altering the decision variables.

4. **Output Variables**

Output variables are the selected key performance indicators for the system (Semwanga, 2009).

Detailed Influence Diagrams and SD Stock and Flow Diagrams

The following sub-models are derived from the detailed influence diagrams: 1. Requirements, 2. Information Quality, 3. Service Quality, 4. System Quality, 5. User Satisfaction, 6. Systems Use, 7. Net Benefits and 8. Top Management Support.

Each influence diagram is converted into a SD stock and flow sub-model as explained in the subsequent tables and diagrams.

Requirements Influence Diagram

Tables 4.1, 4.2 and 4.3, present a brief description of variables associated with the requirements influence diagram. The variables in these tables were adopted from Williams (2003).

Table 4.1: Description of Variables for the Requirements Influence Diagram (1)

Variable	Brief Description	Reference
Documents Reviewed	The total number of requirements documents that have gone through the review process	Williams, 2003
Elicitation Fraction Variation	It is assumed that this fraction is equivalent to 90% of a normal requirements document	Williams, 2003
Information Quality	Represents the desirable characteristics of the system outputs like relevance, understandability, accuracy, conciseness and usability.	Petter *et al.*, 2008
Initial Process Definition	This is the initial statement of requirements in pages	Williams, 2003
Initial Preparation Time	This is a fraction of the requirements engineering process time used for preparing documents and securing agreements from the customer to start the project. The initial preparation time is set at 0.5 months.	Williams, 2003
Manpower	Extra demand for Requirements Engineers	Williams, 2003
New Requirements Generated	The number of requirements generated by users during verification	Williams, 2003
Normal Acceptance Fraction	The rate at which reviewers accept requirements	Williams, 2003
Normal Requirements Document Size	An average requirements document has about 50 to 250 pages for Business and Critical mission defense systems respectively	Williams, 2003
Request Queue	This is queue for change requested as a result of reviews and also for new requirements capture and analysis	Williams, 2003
Requirements Document	This is a complete statement of the requirements	Williams, 2003
Requirements Management	The maintenance of specification of requirements into functional and non functional ones	Williams, 2003
Requirements Modeling	Extraction of use cases from functional requirements	Williams, 2003

Table 4.2: Description of Variables for the Requirements Influence Diagram (2)

Variable	Brief Description	Reference
Requirements Volatility	The ratio of the total number of requirements in terms of additions, deletions and modifications, to the total number of requirements over a period of time	Tharkurta and Ahlemann, 2010
Number of Requirements Modified	Total number of requirements modified during analysis	Williams, 2003
Quality of IS	A measure of the convenience and ease of use of IS	Zmud, 1979
Quality Requirements	Requirements that meet the standard of quality, which makes it possible to actually deploy the system.	Henderson, 2006
Reliability	A measure of the consistency or stability of the IS	Lui *et al.*, 2005
Replacement of Implemented Reqments	The number of replacement requirements due to request for changes	Williams, 2003
Requirements Dev. Rate	The rate at which requirements get accepted.	Williams, 2003
Total Error Reworked	This is the accumulated requirements pages rejected as a result of the review process.	Williams, 2003
User Satisfaction	The net feeling of pleasure or displeasure resulting from aggregating all the benefits that a person hopes to receive from interaction with the IS	Seddon and Kiew, 1994
User Training	By giving users some perspective on how the IS functions, this enables them learn faster and they will be more likely to use the system	Williams, 2003
System Quality	The quality of IS from the technical/production perspective. It leads to higher individual productivity	DeLone and McLean, 2003
Systems use	Is a measure of the effectiveness/influence level of actual and reported use of systems	DeLone and McLean, 2003
Time pressure	Is the negative effect of time pressure on requirements engineers leading to errors	Williams, 2003
Number of Requirements Deleted	This is the number of requirements deleted as result of the review process	Williams, 2003

Table 4.3: Description of Variables for the Requirements Influence Diagram (3)

Variable	Brief Description	Reference
New Requirements	These are the new requirements that come in through request for change	Williams, 2003
Requirements Changes	These occur due to changes in the structure of any part in the organization	Chua *et al.*, 2008
Fraction Variation	It is assumed that this fraction is equivalent to 90% of a normal requirements document	Williams, 2003
Process Start	This is the rate at which all constraints are safe to start a requirements engineering process	Williams, 2003

Figure 4.2 presents the variables and relationships associated with the requirements sub-model. When requirements are kept under control, this minimizes requirements changes and ensures projects are completed with minimal changes in cost, scope and time.

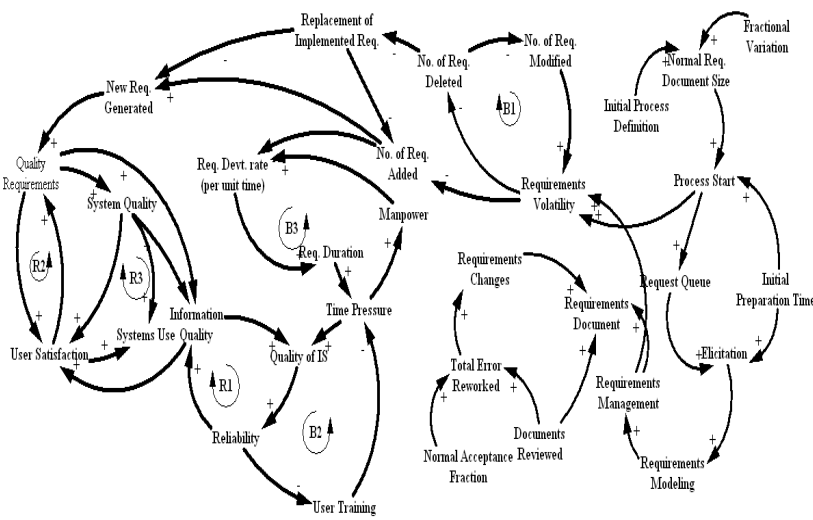

Figure 4.2: Requirements Influence Diagram [adapted from Williams, 2003]

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This ensures that standards are adhered to and users support the introduction of the IS. The sub-model presents three balancing loops B1, B2 and B3, and three reinforcing loops R1, R2 and R3. Here, quality requirements are observed to increase system quality as well as information quality (see Table 3.4).

Loop B1, a balancing loop represents the role of requirements volatility in determining

the behavior of requirements.

Increasing the number of requirements deleted increases the number of requirements modified and hence increased requirements volatility. As seen in subsequent loops, requirements volatility is responsible for other effects on requirements (Ferreira *et al.,* 2009; Williams, 2000). Loop B2, a balancing loop, represents the role of training in an information system. Improved training results into decreased time pressure for the information systems personnel. A decrease in time pressure results into improved quality of the information system because the IT staff would be making fewer errors, leading to higher reliability of the information system (DeLone and McLean, 2002; Lindroos, 1997; Swanson, 1997; Bailey and Pearson, 1983).

Loop B3, a balancing loop, represents manpower issues in an information system. A motivated team of staff gives rise to an increased requirements development rate, reduces the requirements duration as well as manpower time pressure (Williams, 2004).

Loop R1, a reinforcing loop, deals with quality issues of the information system. Improvement in the information quality leads to increased quality of the information system and hence its reliability.

Loop R2, a reinforcing loop, represents the quality of requirements. With improved quality of requirements, more requirements will be implemented resulting into improved system quality (Petter *et al.,* 2008; Henderson, 2006; Williams, 2002).

Loop R3, a reinforcing loop, represents the role of quality requirements in influencing the quality of information derived from an information system. An increase in the quality of requirements increases the information quality, which in turn leads to increased user satisfaction. Increased user satisfaction leads to improved quality requirements (Ferreira *et al.,* 2009; Williams, 2004).

Requirements Sub-model Stock and Flow

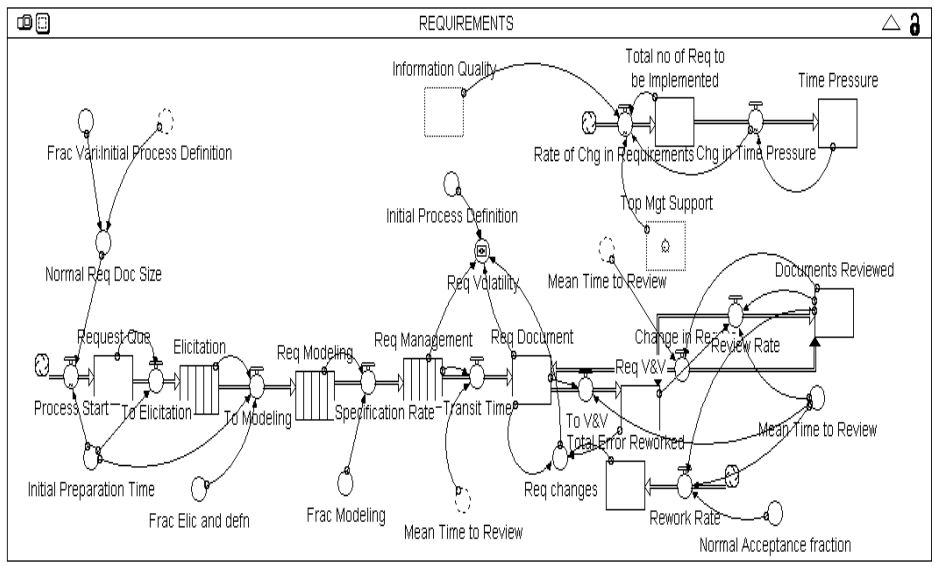

Figure 4.3: The Requirements Sub-model Stock and Flow

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The input variables in the requirements sub-model are presented below:

Table 4.4: Input Variables for Requirements Sub-model

No.	Input Variable	Unit
1	Fraction variation	fraction
2	Process definition	pages
3	Normal requirements document size	pages
4	Initial preparation time	month
5	Fraction elicitation and definition	fraction
6	Fraction Modeling	fraction
7	Initial process definition	pages
8	Mean time to review	months
9	Normal acceptance fraction	fraction

The state variables in the requirements sub-model are presented below:

Table 4.5: State Variables for Requirements Sub-model

No.	State Variable	Unit
1	Process Start	unitless
2	Request Queue	pages
3	Requirements Modeling	pages
4	Requirements Management	pages
5	Requirements Document	pages
6	Total Error Reworked	errors
7	Requirements Verification and Validation	pages
10	Documents Reviewed	pages
11	Total Number of Requirements to be Implemented	pages
12	Time Pressure	months

The rate variables in the requirements sub-model are presented below:

Table 4.6: Rate Variables for Requirements Sub-model

No.	Rate Variable	Unit
1	To Modeling	pages/month
2	Specification Rate	pages/month
3	Change in Requirements	pages/month
4	Transit Time	pages/month
5	Rework Rate	pages/year

Description of the Requirements Sub-model

The requirements sub-model as presented in Figure 4.3, is a model that includes request for requirements, elicitation, modeling and management of requirements. It is developed to understand and model the characteristics of requirements in an information system. Assuming steady state conditions, requirements are created and then these are passed through the requirements engineering process. The rate at which requirements in the system increases is mainly a function of the requirements request queue, requirement elicitation, requirements modeling and requirements management. The level to which the requirements rise is determined by the requirements volatility and the total requirements to be implemented.

Information Quality Influence Diagram

Table 4.7 presents a brief description of variables for the information quality influence diagram. Other variables have already been described in the requirements sub-model and are not described here.

Table 4.7: Description of Variables for Information Quality Influence Diagram

Variable	Brief Description	Reference
Accuracy	A measure of the level at which information is correct, free of errors and relevant for information consumers	Shannon and Weaver, 1949
Availability of IS	Refers to the up time of the IS as compared to the total time the IS is in operation	Yusof and Kuljis, 2008
Completeness	The extent to which data are of are of sufficient breadth, depth and scope for the task at hand	Petter *et al.*, 2008
Information Relevance	The degree of congruence between what the user wants or requires and what is provided by the information products and services	Bailey and Pearson, 1983
Meeting of IS needs	Measures how well users everyday information needs are satisfied	Petter *et al.*, 2008
Quality of IS Team	A measure of how well the IS team manages its core functions	Petter *et al.*, 2008
Responsiveness of IS team	A measure of how the IS team provide prompt service to users	DeLone and McLean, 2003
Service Quality	A measure of the quality of the IS team	DeLone and McLean, 2003
Timeliness of information	Reflects how up-to-date the information is with respect to the task it is used for	Pipino *et al.*, 2002

Figure 4.5 presents three reinforcing loops, R4, R5 and R6. Here, improved information quality is seen to enhance user satisfaction (see table 3.5)

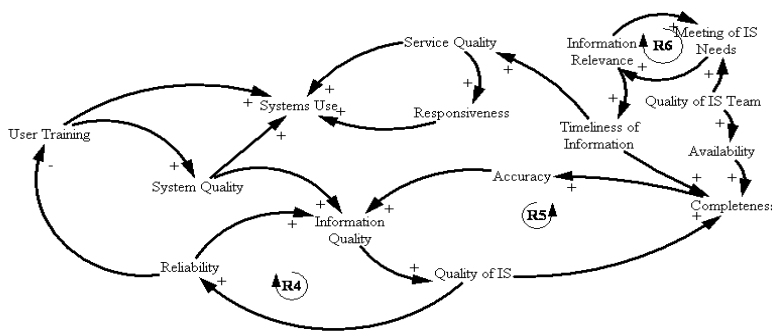

Figure 4.4: Information Quality Influence Diagram

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Loop R4, a reinforcing loop, indicates that improved information quality increases the quality of the information system, which gives rise to greater system reliability which in the long run enhances the information quality derived from the information system (Petter *et al.,* 2008; DeLone and McLean, 2003). reliability is a quantifiable measure useful in the control and management of IS. It provides an early warning about the quality of the IS, hence the quality of outputs from the IS; and identifies the areas where trouble lies (Fatemeh, 1987).

Loop R5 reinforces the concept of good information quality in that the quality of the information system will ensure completeness and accuracy of information, thus generating better information quality (Petter *et al.,* 2008; DeLone and McLean, 2003). On the other hand, Loop R6, a reinforcing loop shows that an improvement in information relevance helps the IS in meeting the information needs of users.

Information Quality Sub-model Stock and Flow

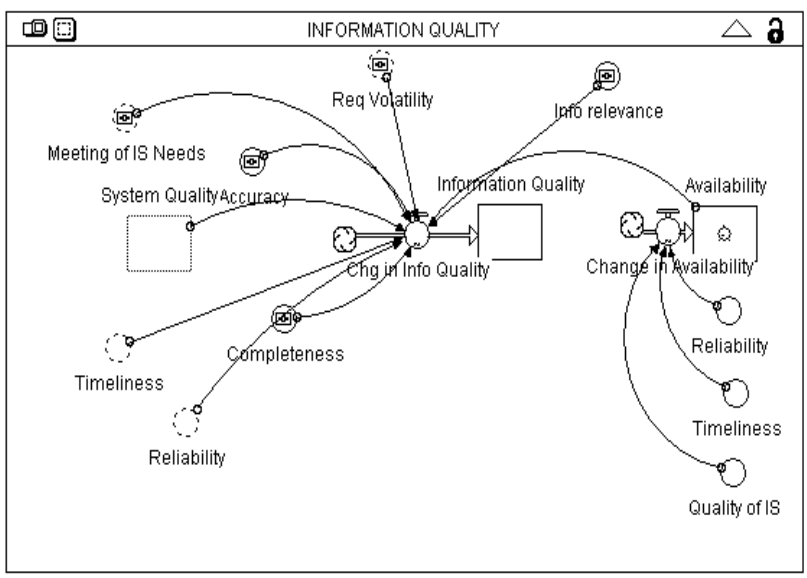

Figure 4.5: The Information Quality Sub-model Stock and Flow

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Table 4.8: Input Variables for Information Quality Sub-model

No.	Input Variable	Unit
1	Quality of IS	unitless
2	Reliability	unitless
3	Timeliness	unitless
4	Availabilty	unitless
5	Information Quality	unitless
6	Completeness	unitless

The state variables in the information quality sub-model are presented below:

Table 4.9: State Variables for Information Quality Sub-model

No.	State Variable	Unit
1	Availability	unitless
2	Information Quality	unitless
3	System Quality	unitless

The rate variables in the information quality sub-model are presented below:

Table 4.10: Rate Variables for Information Quality Sub-model

No.	Rate Variable	Unit
1	Change in Information Quality	1/year
2	Change in Availability	1/year

Description of the Information Quality Sub-model

The information quality sub-model as presented in Figure 4.5, represents the role that information quality plays in an information system. It is a model that includes information quality, the availability of the information system as well as system quality. It is developed to understand and model the characteristics of information quality in an information system. The rate at which the information quality in the system increases is mainly as a function of the accuracy of the information fed into the system, the quality of IS, timeliness of information fed into the system, the quality of the IS, timeliness of information, the reliability of the information system, the availability of the information system as well as the requirements volatility.

Service Quality Influence Diagram

Figure 4.6 presents the variables and relationships associated with service quality. This sub-model demonstrates the importance of service quality as far as user satisfaction and job performance are concerned.

Table 4.11 presents a brief description of variables for the service quality influence diagram.

Table 4.11: Description of Variables for Service Quality Influence Diagram

Variable	Brief Description	Reference
Effectiveness	Is the rate of actual outputs compared to the planned ones	Dong *et al.*, 2009
Improved Quality of work done	Is a measure of decision-making performance and effectiveness	DeLone and McLean, 2003
Top Management Support	Refers to the senior executives favorable attitude toward, and explicit support for IS	Petter *et al.*, 2008
Willingness to use the IS	Measure of the level of commitment and participation of the users of IS	Leclercq, 2007

Figure 4.6 presents three reinforcing loops R7, R8 and R9. Here, service quality is seen to influence service quality (see table 3.6). Loop R7, a reinforcing loop, shows how an increase in information relevance results into improved service quality and user satisfaction. These in turn result in improved information relevance.

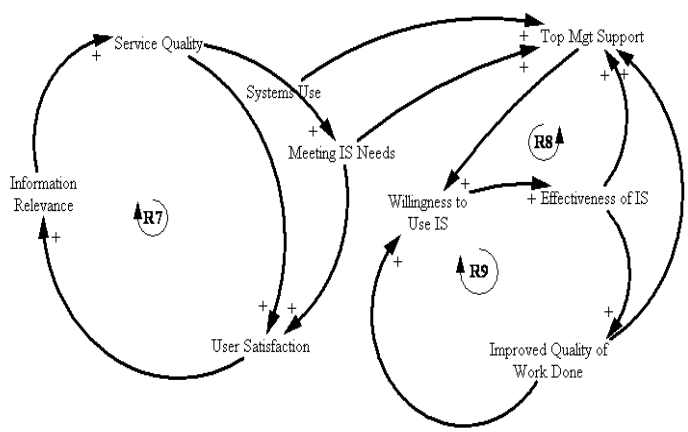

Figure 4.6: Service Quality Influence Diagram

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Loop R8, a reinforcing loop demonstrates that top management support is very influential

in influencing users in participating in information systems activities. This gives rise to increased effectiveness of the information system resulting into increased top management support (DeLone and McLean, 2003; Guimaraes and Igbaria, 1997; Ives *et al.,* 1980). R9, reinforces the notion that an increase in the willingness to use the information system, apart from fostering information system effectiveness, leads to improvement in the quality of work done. This motivates the users to continuously use the information system. (Sabherwal *et al.,* 2006; DeLone and McLean, 2003).

Service Quality Sub-model Stock and Flow

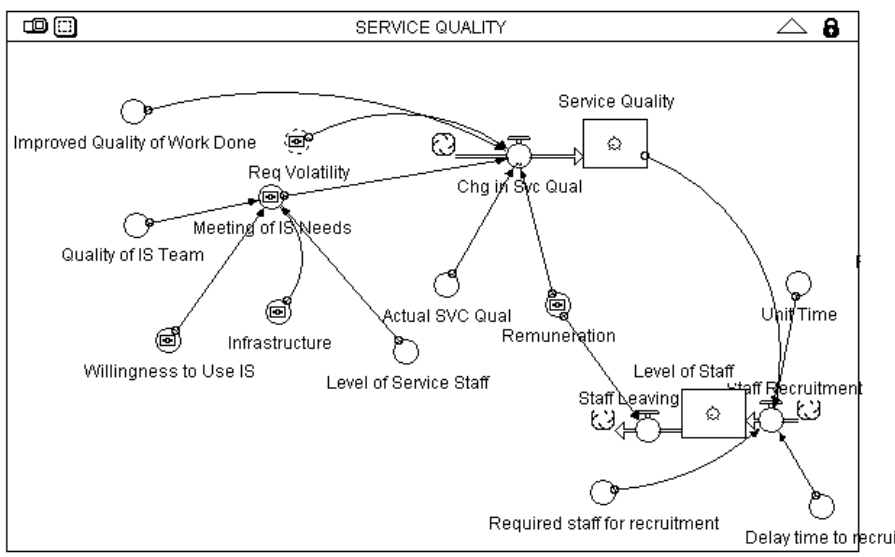

Figure 4.7: The Service Quality Sub-model

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Table 4.12: Input Variables for Service Quality Sub-model

No.	Input Variable	Unit
1	Quality of IS team	unitless
2	Actual service quality	unitless
3	Level of service	unitless
4	Required staff for recruitment	people
5	Delay time to recruit	months
6	Unit time	months

The state variables in the service quality sub-model are presented below:

Table 4.13: State Variables for Service Quality Sub-model

No.	State Variable	Unit
1	Level of staff	unitless
2	Service quality	unitless

The Rate variables in the service quality sub-model are presented below:

Table 4.14: Rate Variables for Service Quality Sub-model

No.	Rate Variable	Unit
1	Change in service quality	1/year
2	Staff leaving	1/year
3	Staff recruitment	1/year

Description of the Service Quality Sub-model

The service quality sub-model as presented in Figure 4.7, is a model that includes service quality and the level of staff in the information system. It represents the role of service quality in determining IS success. The rate at which the value of service quality is driven by improved quality of work done, quality of IS team, willingness to use the IS, infrastructure levels, requirements volatility and staff remuneration.

Systems Use Influence Diagram

Figure 4.8 presents the variables and relationships associated with systems use. The sub-model highlights the relationship that systems use is directly linked to the effectiveness of the system.

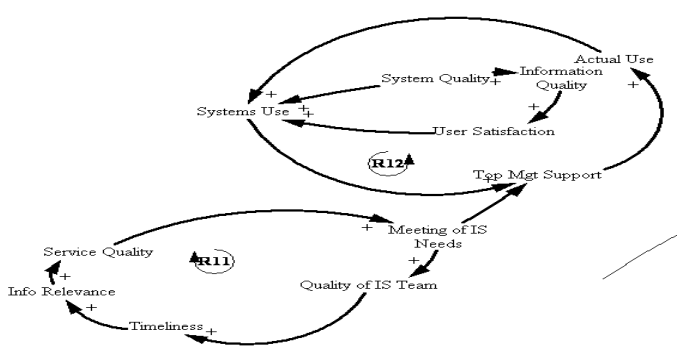

Figure 4.8: Systems Use Influence Diagram

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Figure 4.8 presents two reinforcing loops R11 and R12. In this figure, it is shown that top management support is the trigger that is a key to actual use of the information system. (see table 3.8).

The only variable that belongs to this sub-model and has not been described is Actual Use. Actual use is defined as a measure of the level of use as reported by the system in terms of queries by time, connect time or number of computer functions utilized (DeLone and McLean, 2003).

R11, a reinforcing loop, illustrates that the quality of the information systems team improves the timeliness and relevance of information derived from an information system. This leads to increased service quality which in turn leads to the information system meeting the needs of the users (Sabherwal *et al.,* 2006; Sauer and Cuthbertson, 2003; Sharma and Yetton, 2003; Torkzadeh, 1996).

R12, a reinforcing loop shows that top management support leads to actual use of the IS resulting in increased use of the IS, this in turn leads to greater top management support (Sabherwal *et al.,* 2006; Purvis *et al.,* 2001; Markus, 1983).

Systems Use Sub-model Stock and Flow

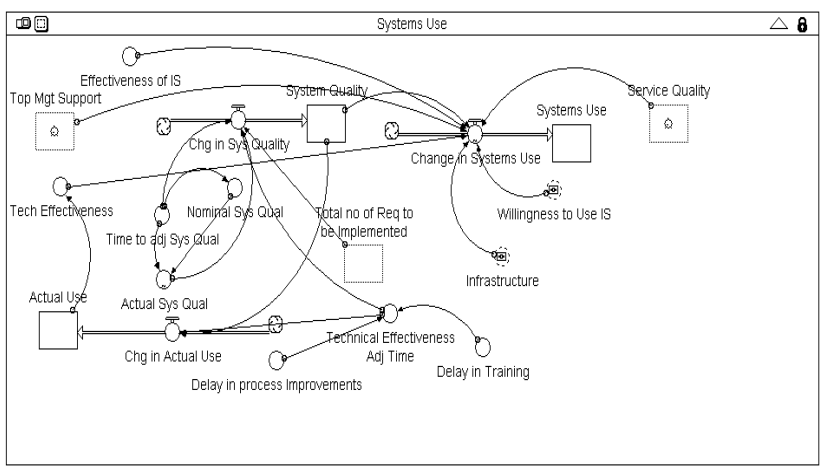

Figure 4.9: The Systems Use Sub-model

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Table 4.15: Input Variables for Systems Use Sub-model

No.	Input Variable	Unit
1	Effectiveness of IS	unitless
2	Delay in Training	months
3	Delay in process improvements	months
4	Effectiveness of IS	unitless
5	Willingness to Use IS	unitless
6	Technical Effectiveness Adjustment Time	months

The state variables in the systems use sub-model are presented below:

Table 4.16: State Variables for Systems Use Sub-model

No.	State Variable	Unit
1	Actual use	unitless
2	Top management support	unitless
3	System quality	unitless
4	Systems use	unitless
5	Service quality	unitless
6	Total number of requirements to be implemented	unitless

The Rate variables in the systems use sub-model are presented below:

Table 4.17: Rate Variables for Systems Use Sub-model

No.	Rate Variable	Unit
1	Change in actual use	1/year
2	Change in system quality	1/year
3	Change in system use	1/year

Description of the Systems Use Sub-model

The systems use sub-model as presented in Figure 4.9, is a model that includes top management support, actual use, service quality, system quality and total number of requirements to be implemented. The rate of increase of systems use is mainly a function of the effectiveness of IS, infrastructure levels, willingness to use the IS and the technical effectiveness of the IS team.

User Satisfaction Influence Diagram

Figure 4.10 presents the variables and relationships associated with user satisfaction. Our interest in user satisfaction results from the fact that user satisfaction is a direct reflection of customer or user expectations.

The only variable that is not yet described for the User satisfaction sub-model is improved performance, as the other variables have already been described before. Improved performance is defined as a measure of users change in activity, decision-making productivity and perception of information usefulness or importance (Zmud, 1979).

Figure 4.10 presents three reinforcing loops R13, R14 and R15. In the figure, it is indicated that system quality affects user satisfaction as well as information quality, which in turn affects user satisfaction. User satisfaction as seen from the Figure 4.10 is a key player, giving rise to loops 14 and 15 (see table 3.9).

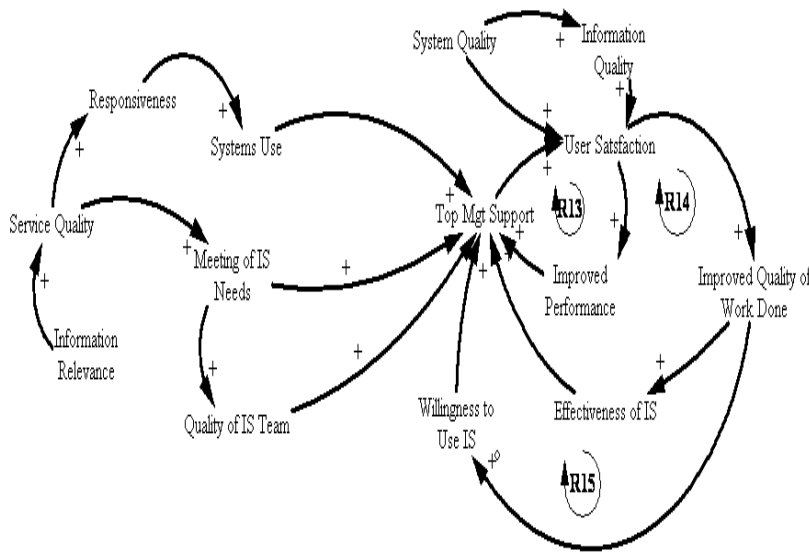

Figure 4.10: User Satisfaction Influence Diagram

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R13, a reinforcing loop, presents the role of top management support in ensuring user satisfaction. Increased top management support leads to increased user satisfaction. Increased user satisfaction gives rise to improved performance thus generating more top management support (Petter *et al.,* 2008; DeLone and McLean, 2003; DeLone and McLean, 2002; Hoogeveen, 1997; DeLone and McLean, 1992).

R14, a reinforcing loop represents the role of user satisfaction in ensuring improved quality of the work done. An increase in user satisfaction results into improved quality of work done, which increases the effectiveness of the information system leading to greater top management support (Masrek *et al.,* 2007; Sabherwal *et al.,* 2006; Andresen, et al., 2000; Doll and Torkzadeh, 1991).

R15, a reinforcing loop, presents the role of improved quality of work done enticing users to willingly participate in the use of the information system. This in turn leads to more top management support (Sabherwal *et al.,* 2006; DeLone and McLean, 2003).

User Satisfaction Sub-model Stock and Flow

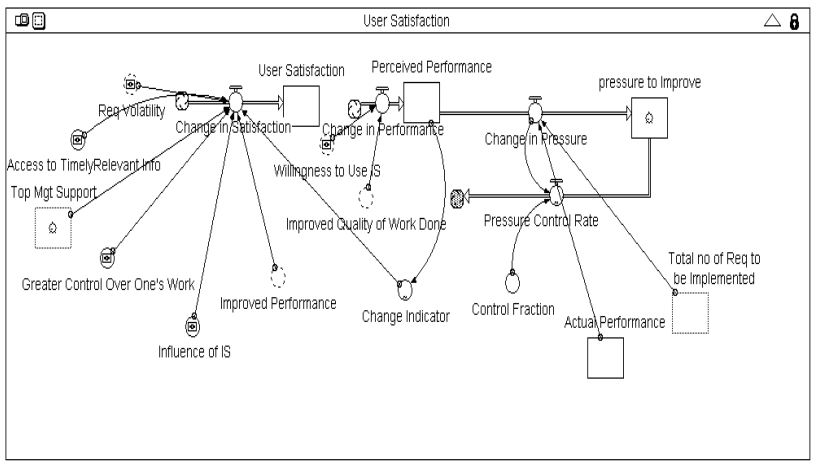

Figure 4.11: The User Satisfaction Sub-model

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Table 4.18: Input Variables for User Satisfaction

No.	Input Variable	Values
1	Improved performance	unitless
2	Control fraction	fraction
3	Improved quality of work done	unitless

The state variables in the user satisfaction sub-model are presented below:

Table 4.19: State Variables for User Satisfaction Sub-model

No.	State Variable	Unit
1	User satisfaction	unitless
2	System quality	unitless
3	Top management support	unitless
4	Perceived perfomance	unitless
5	Actual perfomance	unitless
6	Pressure to improve	unitless

The Rate variables in the user satisfaction sub-model are presented below:

Table 4.20: Rate Variables for User Satisfaction Sub-model

No.	Rate Variable	Unit
1	Change in satisfaction	1/year
2	Change in perfomance	1/year
3	Change in pressure	1/year
4	Pressure control rate	1/year

Description of the User Satisfaction Sub-model

The user satisfaction sub-model as presented in Figure 4.11, is model that includes system quality, user satisfaction, top management support, perceived performance, pressure to improve and actual performance. The rate of increase of user satisfaction is driven by requirements volatility, greater control over one's work, influence of IS, improved performance and access to timely/relevant information.

Net Benefits Influence Diagram

Figure 4.12 presents the variables and relationships associated with net benefits. Some of the net benefits from an IS is that it makes work easier and there is greater control over one's work, which are instrumental in ensuring information systems success.

Net benefits is a measure of the level of impact of the IS on customers, suppliers, employees, organizations, markets, industries and economies (DeLone and McLean, 2003).

Figure 4.12 presents four reinforcing loops R16, R17, R18 and R19. Net Benefits are best observed as improved performance (see table 3.10).

R16, a reinforcing loop presents the effectiveness of an information system ensuring user satisfaction. An increase in the effectiveness of an information system will lead to an increase in user satisfaction, which leads to greater willingness of users to participate in the IS activities resulting in greater effectiveness of the information system (Sabherwal *et al.,* 2006; DeLone and McLean, 2003).

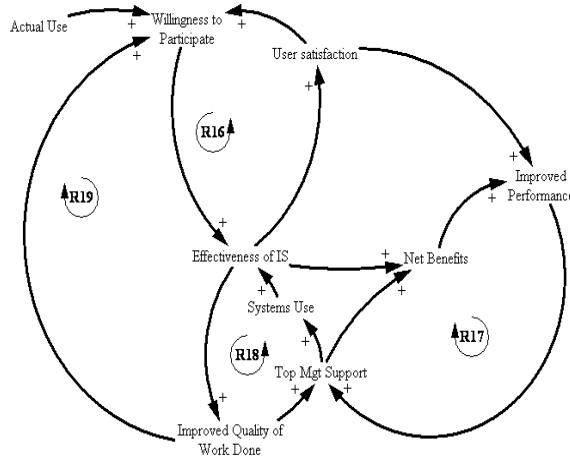

Figure 4.12: Net Benefits Influence Diagram

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R17, a reinforcing loop, represents the role of net benefits derived from the information system it plays in ensuring information systems success. An increase in the net benefits derived from information system leads to improved performance within the organization. The result of this is to increase the confidence of management in the information system giving rise to more benefits (Petter *et al.,* 2008; DeLone and McLean, 2003).

R18, a reinforcing loop presents the role of top management support in ensuring the effectiveness of an information system. Increased top management support leads to increased effectiveness of the information system. An increase in the effectiveness of the information system gives rise to improved quality of work, again leading to increased top management support (Dong *et al.,* 2009; Masrek et al., 2007; Sabherwal *et al.,* 2006; Andresen, *et al.,* 2000; Doll and Torkzadeh, 1991).

R19, a reinforcing loop, demonstrates how improved quality of work done supports the use of the information system. Improved quality of work done results in increased willingness of users in participating in the information system activities which in turn leads to greater effectiveness of the information system, which leads to increased improved quality of work done (Sabherwal *et al.,* 2006; DeLone and McLean, 2003; Andresen, ıet al., 2000).

Net Benefits Sub-model Stock and Flow

In the Net Benefits Sub-model as seen in Fig 4.13, effectiveness of an IS, the meeting of IS needs of users and the improved quality of the work done by users are some of the benefits to be derived from an information system. These lead to dynamics which are observed in the change in benefits as seen below.

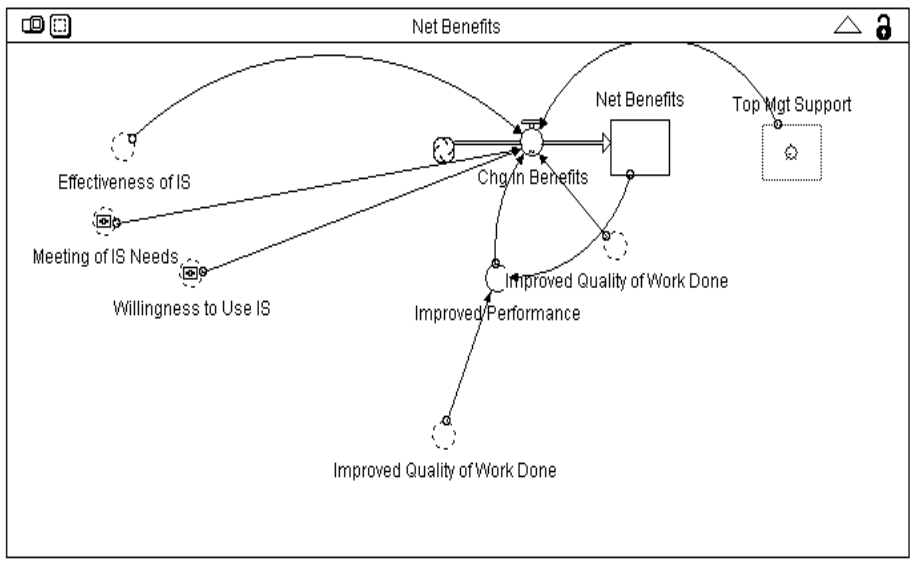

Figure 4.13: The Net Benefits Sub-model

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Table 4.21: Input Variables for Net Benefits

No.	Input Variable	Values
1	Effectiveness of IS	unitless
2	Meeting of IS Needs	unitless
3	Improved Performance	unitless
4	Willingness to use IS	unitless

The state variables in the net benefits sub-model are presented below:

Table 4.22: State Variables for Net Benefits Sub-model

No.	State Variable	Unit
1	Top management support	unitless
2	Net benefits	unitless

The Rate variable in the net benefits sub-model is presented below:

Table 4.23: State Variables for Net Benefits Sub-model

No.	Rate Variable	Unit
1	Change in benefits	1/year

Description of the Net Benefits Sub-model The net benefits sub-model as presented in Figure 4.13, is a model that includes net benefits and top management support. The rate of increase of net benefits is driven by effectiveness of IS, meeting of IS needs, willingness to use IS, improved performance and improved quality of work done.

Top Management Support Influence Diagram

Top management support is seen to drive quality requirements, user satisfaction and service quality (see table 3.11). At the same time, it affects the IT manager's decision effectiveness (see table 3.5). On the other hand, quality requirements help improve the quality of information derived from an information system (see table 3.4).

Figure 4.14 presents two reinforcing loops R20 and R21.

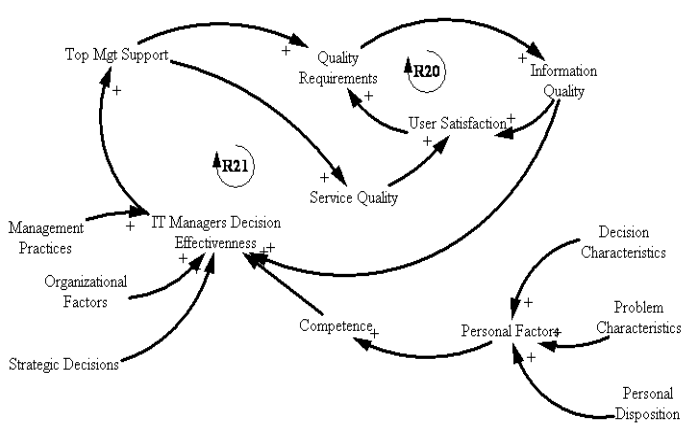

Figure 4.14: Top Management Support Influence Diagram

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R20, a reinforcing loop, demonstrates that an increase in the quality of information derived from an information system results into increased user satisfaction which in turn leads

to better quality requirements that in the end contribute to increased user satisfaction (Williams, 2004; DeLone and McLean, 2003; Gelderman, 1998; Bailey and Pearson, 1983). R21, a reinforcing loop presents the role of top management support in ensuring quality requirements by giving management direction. Increased top management support gives rise to higher quality requirements ensuring that the quality of information derived from an information system is high. This in turn increases the decision effectiveness of the IT manager. Increased decision effectiveness of the IT manager then leads to increased top management support (Velasquez *et al.,* 2009; Petter *et al.,* 2008; Masrek *et al.,* 2007; Sabherwal *et al.,* 2006; DeLone and McLean, 2003).

Table 4.24 presents a brief description of variables for the Top Management Support influence diagram.

Table 4.24: Description of Variables for Top Management Support Influence Diagram

Variable	**Brief Description**	**Reference**
Competence	A measure of the right knowledge, skills and abilities that determine productivity and customer satisfaction, but also the ability to compete in fast changing environments	Flynn and Williams, 2000
Decision Characteristics	A measure of the level of emotion, imagination, and memories crystallized into occasional insights.	Sinclair and Ashkanasy, 2005
IT Managers Decision Effectiveness	The degree and manner in which a leader involves others in the decision-making process	Velasquez *et al.,* 2009
Management Practices	The more the employees behave according to the formal rules, the better the organizational performance is assumed to be.	Hoogervost *et al.,* 2004
Organizational Factors	A measure of how politics, culture and senior management support, affect decision making concerning investments in IS	Harrison and Pelletier, 2000
Personal Disposition	A measure of the cognitive and affective structures maintained by individuals to facilitate their adjustment to the events, people and situational factors encountered in life	Sinclair and Ashkanasy, 2005
Personal Factors	A measure of the level of emotional involvement pertaining to decision making	Sinclair and Ashkanasy, 2005
Problem Characteristics	A measure of the clarity, time issues, multiple people, items, or relationships, and interfering or opposing goals	Sinclair and Ashkanasy, 2005
Strategic Decisions	A measure of temporal social, political, and emotional factors, as well as overt and covert influencing tactics.	Adler, 2000

Top Management Support Sub-model Stock and Flow

Top Management support of information systems refers to the degree to which top management understands the importance of the IS function and the extent to which it is involved in IS activities (Lin, 2010; Masrek *et al.,* 2007). And as has been stated before, when the level of Top Management Support is high, senior executives are more likely to attend project meetings related to specific IS, participate in important decisions, and monitor the project.

In the Management Support sub-model as illustrated in Figure 4.15, a manager's personal factors determine his competence at his job. On the other hand, competence coupled with the strategic decisions to be taken, IT investment, as well as external factors, lead to dynamics that are observed in the IT manager's decision effectiveness. This in turn will determine the level of support the manager will give to the operationalization of an IS.

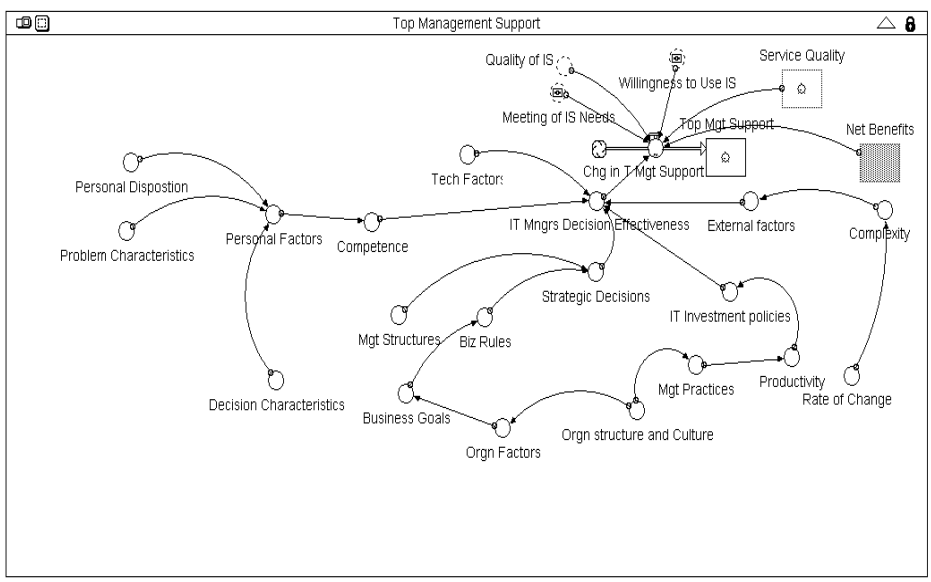

Figure 4.15: The Top Management Support Sub-model

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Table 4.25: Input Variables for Top Management Support

No.	Variable	Unit
1	Quality of IS	unitless
2	Personal Disposition	unitless
3	Problem characteristics	unitless
4	Decision characteristics	unitless
5	Social-technical factors	unitless
6	Organizational factors	unitless
7	Rate of change	unitless

The state variables in the top management support sub-model are presented below:

Table 4.26: State Variables for Top Management support Sub-model

No.	Variable	Unit
1	Top management support	unitless
2	Service Quality	unitless

The rate variable in the Top Management Support sub-model is presented below:

Table 4.27: Rate Variable for Net Benefits Sub-model

No.	Variable	Unit
1	Change in Top management support	1/year

Description of the Top Management Support Sub-model

The top management support sub-model as presented in Figure 4.15, is a model that includes top management support and service quality. The rate of increase of top management support is determined by meeting of IS needs, willingness to use the IS, quality of IS, complexity of IS and IT managers technical effectiveness.

Input Variables

During the modeling process, we held informal interviews with IS managers from URA and came up with a list of input variables that are used as decision variables as presented in Table 4.28 (please see Appendix D). As can be seen, the input variables are soft factors because they cannot be measured by using objective measuring equipment. Rather, they have to be measured and evaluated by people, with people functioning as subjective measuring equipments (Amini, 2011). Examples of qualitative variables used are Accuracy, Remuneration and Completeness. The use of Likert scales is the common way to measure and evaluate soft factors (Williams and Hummelbrunner, 2010; Semwanga, 2009; Madi Bin Abdullah *et al.,* 2008). In this research, we used a ten point Likert scale to give us

enough latitude to enable us observe the output over time in order to help us assess IS over time. The qualitative or soft factors are represented as unitless ranging from 0-10. The variable here are based on the knowledge and opinions of stakeholders. These naturally are subjective and cannot be arrived at objectively, rather the instrument is used in a specific mode and shows the feasibilty of the instrument.

Table 4.28: Decision Variables

Name	Brief Description	Values
Access to timely/relevant information	Access to timely/relevant information	[0-10]unitless
Greater control over one's work	Greater control over one's work	[0-10]unitless
Requirements volatility	Ratio of the total number of requirements changes to the total number of requirements in the system	[0-10]unitless
Willingness to use IS	The level of willingness by users to use the IS	[0-10]unitless
Remuneration	Level of Payment or compensation received for services or employment	[0-10]unitless
Accuracy	Level of how correct, free of errors and relevant information is	[0-10]unitless
Completeness	The extent to which data are of sufficient breadth, depth and scope for the task at hand	[0-10]unitless
Pressure to Improve	Is an accumulation of the need to change as a result of needed improvements	[0-10]unitless
Service quality	Level of quality ot the IS team	[0-10]unitless
Influence of IS	The level to which the IS influences the way IS users make decisions	[0-10]unitless
Top Management Support	The level of the senior executives favorable attitude toward, and explicit support for IS	[0-10]unitless

Output Variables

From the inputs in the tables above, the model makes the calculations which result in the output variables shown in Table 4.29. These output variables are the selected IS success measures for the system.

Table 4.29: Output Variables

No.	IS Success Measure	Variable Description
1	User Satisfaction	User satisfaction is the net feeling of pleasure or displeasure resulting from aggregating all the benefits that a person hopes to receive from interaction with the information system
2	Information Quality	Information quality represents the desirable characteristics of the system outputs like relevance, conciseness, completeness, currency, understandability, accuracy, timeliness and usability

4.6 Conclusion

The findings from the literature reviewed in chapter two (2) and the exploratory study in chapter three (3) indicate the need for a single, simple to use instrument for assessment of IS. This would go a long way in reducing confusion and uncertainty which are promoted through diverse assessment methods, some of which are poorly understood by stakeholders.

The IS assessment instrument based on the studio approach and using System Dynamics was designed to provide these functionalities. It may be deployed in three (3) modes: training mode, communication mode and IS assessment mode. The instrument enables stakeholders to come together, discuss an IS of their choice and using knowledge of this IS, set the values for the variables to be used in simulation experiments to help in assessment of that particular IS.

To evaluate the instrument design, an implementation of the instrument was carried out. in the evaluation, the majority of respondents found it understandable and easy to use. This implementation is discussed in chapter five (5). The usability, usefulness and usage of the instrument was then carried out in chapter six (6).

5. Implementing the Instrument

5.1 The ISASSI Instrument

In order to instantiate the instrument we adopted STELLA modeling software (Ithink® 2007) for a number of reasons. STELLA has the advantage in that we can develop an accessible user-friendly interface that allows non-modelers to arrange and carry out treatments on IS success variables. It also has tools that generate graphs, export and import data. Graphs are an essential attribute for displaying simulation results since they provide a visual result of the simulation that can easily be understood by all stakeholders. The graphs are also useful for checking of errors in the model. In addition, STELLA has an in-built sensitivity analysis function that can also be used for structural or face validation.

A STELLA model consists of three communicating layers that contain progressively more detailed information on the structure and functioning of the model as seen in Figure 5.1

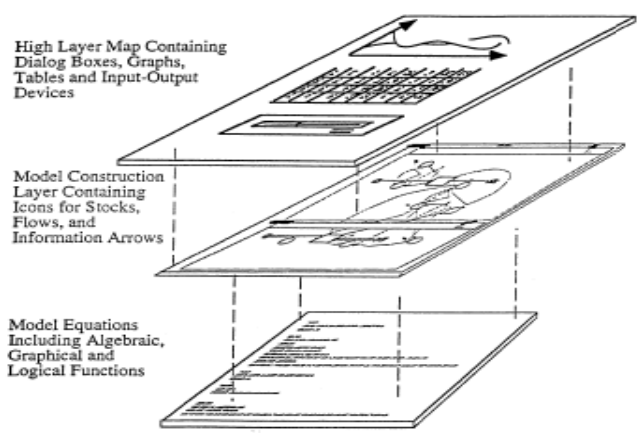

Figure 5.1: STELLA Modeling Environment

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The high-level mapping and input-output layer provides tools to lay out the structure of the model and to enable non-modelers to easily grasp that structure, to interactively run the model and to view and interpret its results. The ease of use of the model at this aggregate level of detail thus enables individuals to become intellectually and emotionally involved with the model (Constanza and Ruth, 1998). Models are constructed in the next lower layer. Here the symbols for stocks, flows and parameters are chosen and connected with each other. Once the structure of the model is laid out on the screen, initial conditions, parameter values and functional relationships can be specified by simply clicking on the respective icons. Dialog boxes appear that ask for the input of data or specification of graphically or mathematically defined functions.

Equally easy is the generation of model output in graphical or tabular form through the choice of icons. With the use of sliders and knobs, a user can respond to the model output by choosing alternative parameter values as the model runs. Subsequent runs under alternative parameter settings and with different responses to model output can be plotted in the same graph or table to investigate the implications of alternative assumptions. Thus, the modeling approach is not only dynamic with respect to the behavior of the system itself but also with respect to the learning process that is initiated among decision makers as they observe the system's dynamics unfold. Using STELLA, and projecting the computer screen onto the wall, the process of model construction can be transparent to a group of diverse stakeholders. Participants can follow the process and contribute their knowledge.

Developing The User Interface

After testing the individual sub-models they were connected together to form a single stock and flow diagram. It was then that we developed the user interface for the instrument. The interface was for presenting the instrument to stakeholders in IS. The objective was to show details of the instrument in an easy to understand way. In this, a number of screens are implemented with buttons for showing the various experimental capabilities as well as making it possible to run simulations as explained in section 5.1.
The main interface the user sees is the control panel presented in Figure 5.2.

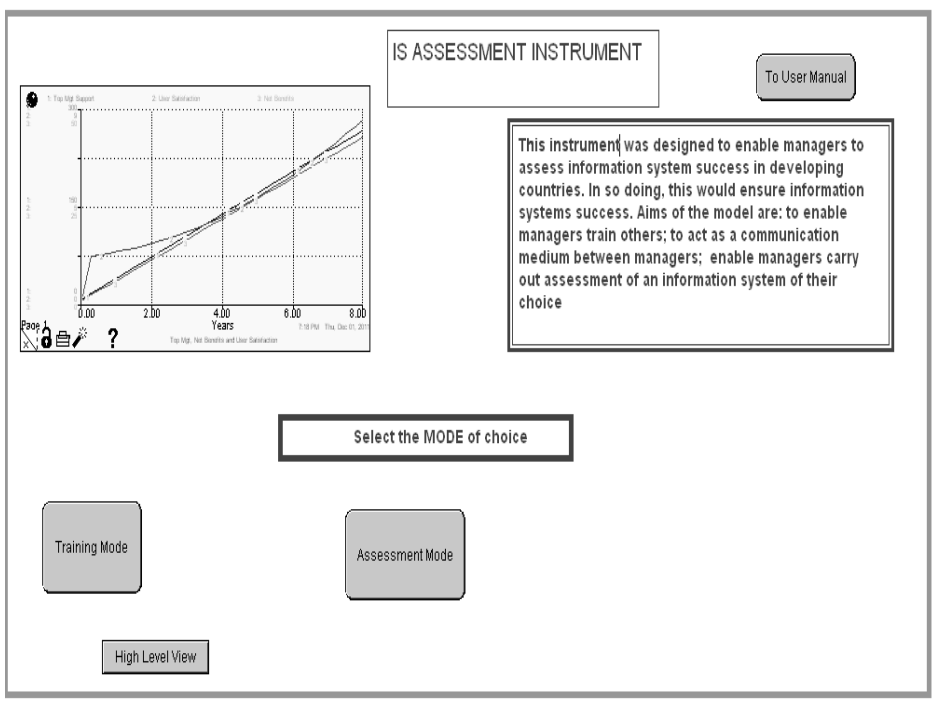

Figure 5.2: ISASSI control panel. The control panel allows the user to experiment with factors affecting IS Success. The results of each run are displayed on the graph in terms of User Satisfaction or Information Quality

Description of Graph Output

Users can run simulation experiments to make observations on the performance of particular variables. Figure 5.3 shows the performance of IS success variables graphically.

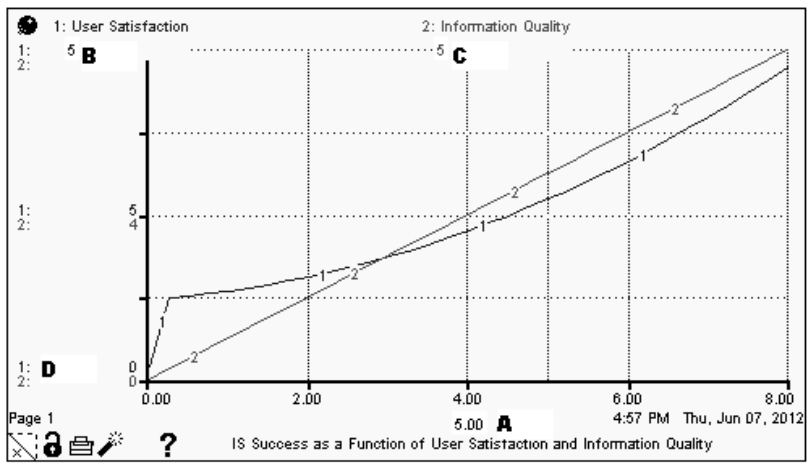

Figure 5.3: IS Success Over Time

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The figure shows a graph of simulated user satisfaction and information quality (unitless) against time (years). The X-axis represents the time in years (0-8) and the Y-axis represents different values of user satisfaction and information quality (0-10). On the left hand side of the graph is shown the hierarchy of the values that are simulated. In the graph, the first simulated entity is User satisfaction, represented by "1" and the second simulated entity is Information quality represented by "2" (see D). This means that the value "5" refers to User satisfaction and "4" refers to Information quality on the Y-axis. In case we wish to observe the simulation results over time, we can move the cursor along the X-axis, and holding it at any point of interest. In this instance, at year 5, represented by "A", the values for User satisfaction "B" and Information quality "C" are both 5. In other words, by moving our cursor along the X-axis, we are able to display the value of simulated user satisfaction or information quality and the time (year) at which this value occurs. we decided to present only 2 variables as output variables, that is, *user satisfaction* and *information quality*. We did not display the other variables because our intention was to assist stakeholders in predicting IS success, not to observe the patterns within the variables. On the other hand, we felt that having graphs showing many variables would confuse stakeholders. A graph showing upto 5 variables is prented in Appendix H.

Description of Tabular Output

An example of a tabular output is illustrated in figure 5.4

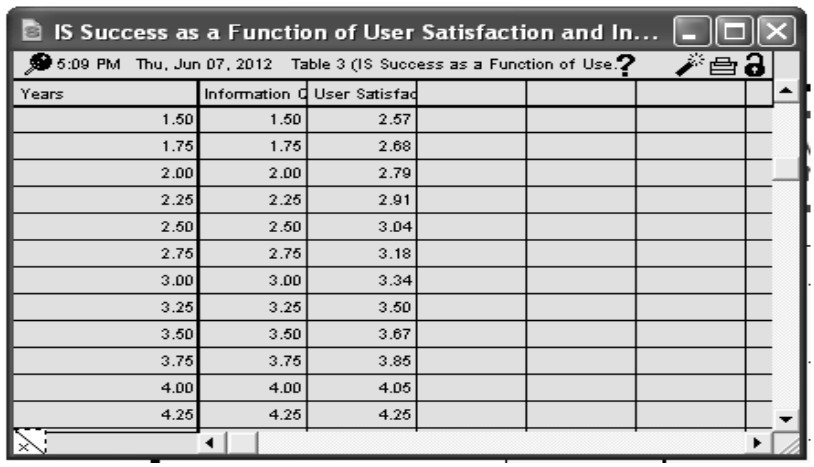

Figure 5.4: IS Success Over Time Presented in Tabular Form

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For reporting purposes we cannot display the entire table as it displays every 0.25 years. We thus extract results every 1 year as shown in the table 5.1 below:

Table 5.1: Tabular Output for IS Success Over Time

Year.	Information Quality	User Satisfaction
1	1.00	2.40
2	2.00	2.79
3	3.00	3.34
4	4.00	4.05
5	5.00	5.00
6	5.90	5.95
7	7.00	7.15
8	8.00	8.51

While the explanation given above provides an explanation about how we implemented the Interface, it does not include a manual for new users. The creation of a user manual follows the steps used to create a screen for its interface. Buttons for navigation are then added like is done for the user Interface. The following section introduces a simple user manual for the ISASSI.

The User Manual

The user manual in this study does not cover installation of the instrument, rather, it covers its use. It thus provides basic information on the ISASSI instrument, but presents detailed instructions on how to use the instrument.

As seen, the instrument has a number of click-able buttons for navigation (see Figure 5.2). In the top right hand corner, there is a button which helps a trainee user navigate to the user manual. On clicking this button, the user is taken to the user manual, illustrated in Figure 5.5. This page presents the user with explanations and directions for using the assessment instrument. On top the left hand corner, there is a button which helps a user navigate back to the main interface. The button on the top right hand corner of the training manual will help the user navigate to the training mode screen, as seen in Figure 5.6.

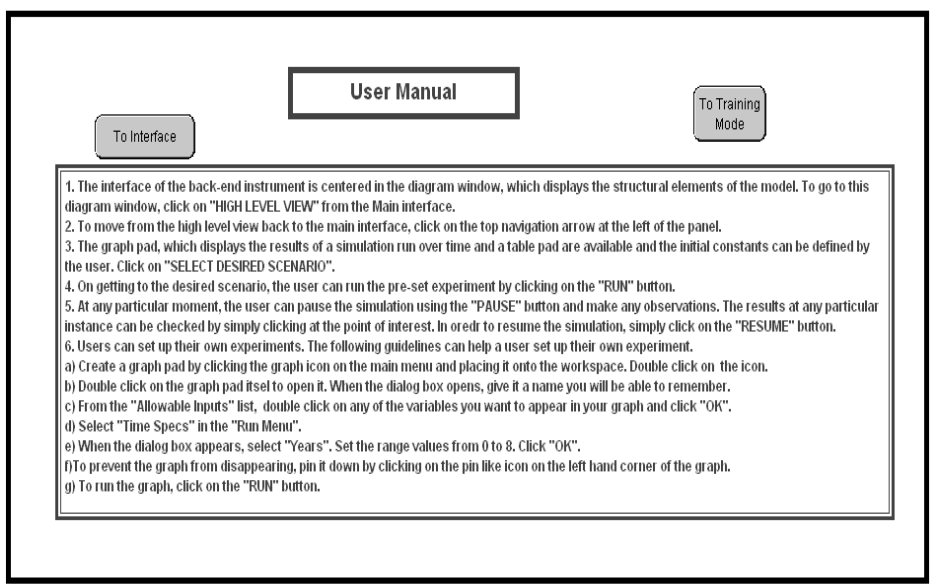

Figure 5.5: A Screen Shot of the User Manual Screen

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Description of the Training Mode

Figure 5.6 presents the screen shot of the training mode. This screen shows a graph pad as well as a table pad. The learner, under the guidance of a skilled user uses the graph and pad to set up experiments by selecting from the available input and output variables. She is able to observe the outputs as well as corresponding changes in the input over time. The quantitative output given by the table re-enforces the visual output from the graph giving deeper insight to the learner.

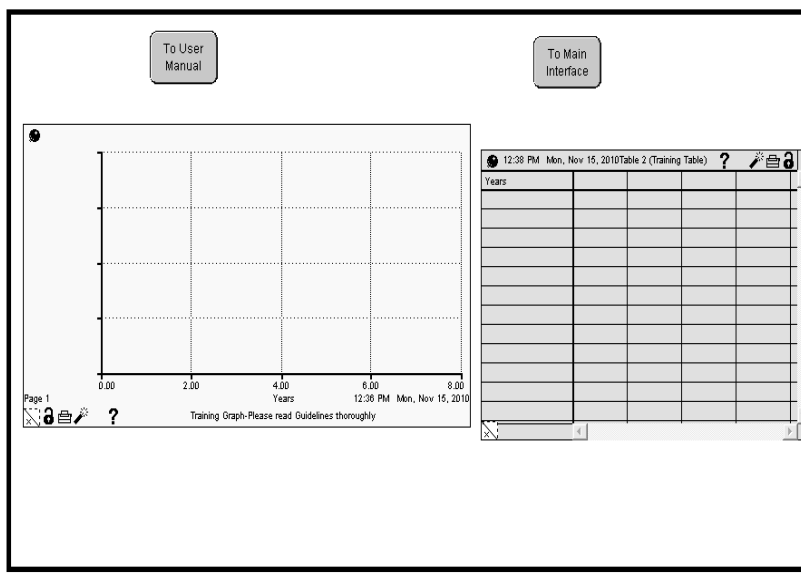

Figure 5.6: A Screen Shot of the Training Mode Screen

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The corresponding Figure 5.7 presents the screen shot of the selection screen, from which the user selects the variables that are available for simulation. The user can select 1 or more variables to experiment with from the allowable ones presented in the Figure in the left hand corner. Once the variable is selected the arrows in the middle are used to place the selected variable in the top right hand window for the 'Selected' variables. In case one needs to de-select a variable, one needs to click on it and use the reverse arrow in the middle to send it to the 'Allowable' pool of variables.

The learner is provided with navigation to either the main interface or to the user manual. The importance of referring to the user manual is to emphasize the importance of reviewing the user instructions for a learner.

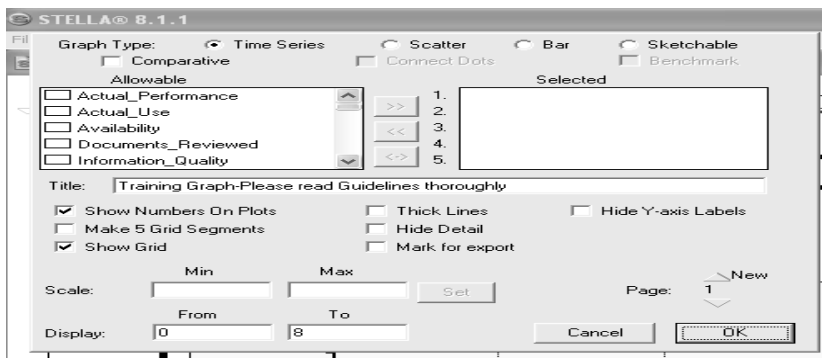

Figure 5.7: A Screen Shot of the Selection Pad

.

Table 5.2: Script for the Training Mode (1)

No.	Task	**Script Procedure**
1	Identify the stakeholders interests and capacity	Ensure the participation of key stakeholders in the IS implementation, maintenance and assessment process This can best be done by stakeholders recording their names and signing a register This has several benefits. Participating stakeholders will improve their understanding of IS success issues, how the instrument works and how assessment is carried out
2	Secure equipment for training	Obtain a Laptop/PC, whiteboard and Projector. The projector is useful for projecting on the white-board to enable everyone participate
3	Give a presentation to the participants about IS	The presentation explains the importance of successful information systems, assessment as well as stakeholder involvement in this activity Participants are introduced to reasons why systems fail and how the IS assessment instrument works
4	Receive feedback from participants	The presentation is followed by a question and answer session with participants. This is then followed by a group discussion of the IS assessment in general

Table 5.3: Script for the Training Mode (2)

No.	Task	Script Procedure
5	Formulate, formalize and review training on instrument	Describe the IS assessment variables Describe the IS assessment process Describe the IS assessment instrument sessions. Collectively agree on the roles of each stakeholder to implement the training Collectively agree on who is responsible for doing what
6	Start the training	To ensure successful training, attention should be given that all staff involved in the training are motivated to participate effectively by regularly demonstrating how the instrument works to re-enforce recall Listening to participants and by regularly acting upon their recommendations When results are obtained, these should be recorded
7	Demonstrate how experiments can be run Allow participants run experiments	It becomes easier for participants to get involved when a demonstration is given Participants are allowed to set up their own experiments and run them In the process, they discover new insights about their IS and IS assessment in general. This enhances their understanding, not only of the instrument but of their IS
8	Demonstrate how experiments can be saved.	Participants are shown how to save their experiments when they are satisfied that these experiments represent the true picture of the IS they are assessing
9	Demonstrate how experiments can be shared with other stakeholders	Participants are shown how to save, export and publish their experiments over the Internet This enables other stakeholders share in the insights that the people that have attended the sessions gain This leads to organizational learning
10	Secure a follow up meeting for assessing IS	Collectively agree on the time period participants will take training and using the instrument and then on meeting for training on the communicating results as well as assessing IS. This commitment ensures that participants take some time off their schedules to work with the instrument
11	Ending of Training	Review the expectations of the participants and invite additional feedback which should then be documented Thank participants for their time

Description of the Communication Mode

Figures 5.8 and 5.9 present the screen shots of the communication mode. This is a screen that stakeholders can use in communicating the results of their experiments on a particular IS, by publishing them over the Web.

Since the instrument is flexible, the stakeholders could communicate information about current performance, using information from users or past performance using information from reports. In Figure 5.8, the file is saved as .TXM file using the isee NetSim protocol.

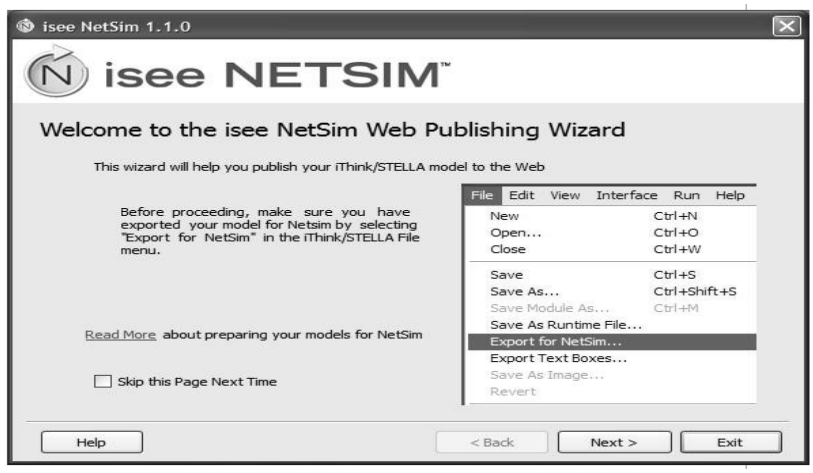

Figure 5.8: The Screen Shot for the Exporting a Model in the Communication Mode

Table 5.4: Script for Exporting a Model in the Communication Mode

No.	Script Procedure
1	Open the model file that you want to publish in STELLA
2	From the File Menu, choose Export for NetSim. Then Save NetSim file as dialog box opens.
3	Navigate to the location where you want to save the file.
4	In the File name box, type the name you want to give the file.
5	In the Save as type box, make sure that NetSim file (*.TXM) is selected
6	Click Save

In Figure 5.9, the second step, which is the configuring of the proxy server from which the stakeholders can download and view the published experiments, is illustrated.

Figure 5.9: The Screen Shot for Publishing a Model in the Communication Mode

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Table 5.5: Script for Publishing a Model in the Communication Mode

No.	Script Procedure
1	Start isee NetSim by double-clicking the isee icon on your desktop The first page of the wizard opens
2	Click Next. The second page of the wizard appears
3	Click the Browse button at the top of the page to navigate to and select the .TXM file that you want to publish
4	Under Publishing URL, select where you want to publish the model To publish the model to Forio Simulate, select Forio Simulate web simulation hosting service To publish the model to any other web site, select Other service: and then type the full URL of the web site where you want to publish the model
5	Under “Login Information”, type your email address and password for the location where you want to publish the model
6	To save your login information for the future, select the Remember me check box
7	If you have already published one or more models, you can see a list of your published models by clicking the View or delete my published models link A web page appears that displays a list of your published models. Use this page to view or delete your published models
8	Select a ”Publishing Mode” for the model To publish and save the model to a location where it can be shared with others, select Publish. If you would like others to be able to download the model file, click the Browse button to navigate to and select the .STM or .ITM file
9	You can now publish the TXM file with isee Netsim

Description of the Assessment Mode

Figure 5.10 presents the screen shot of the assessment mode. This is a screen that stakeholders can use in assessing an information system of their choice. The managers first discuss and fix scores for the input variables that can be experimented with.

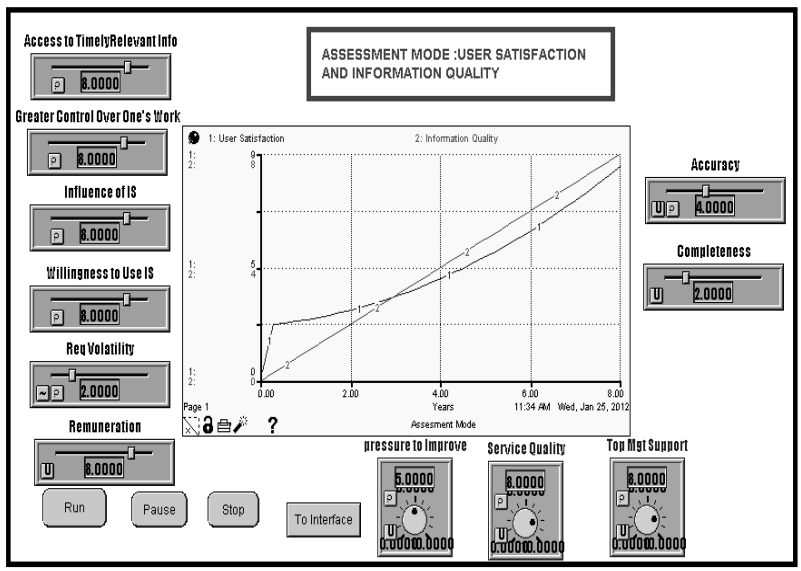

Figure 5.10: The Assessment Mode Screen

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As seen before, buttons are provided for setting the input variables, for running, pausing, resuming and stopping the simulations. Buttons are provided to enable the user navigate to other screens within the communication mode and to the main interface.

The results of a simulation can be saved and shared with other members and can act as a point of reference when another assessment session is run after some time has elapsed in the time of the information system.

Table 5.6: Script for the Assessment Mode (1)

No.	Task	**Script Procedure**
1	Identify the stakeholders their interests and capacity.	Ensure the participation of key stakeholders in the IS assessment process This can best be done by stakeholders recording their names and signing a register This has several benefits. Participating stakeholders will improve their understanding of IS success issues, how the instrument works and how assessment is carried out
2	Secure equipment for training	Obtain a Laptop/PC, white-board and Projector. The projector is useful for projecting on the white-board to enable everyone participate
3	Give a presentation to participants on IS assessment	The presentation explains the IS assessment variables, IS assessment as well the importance of stakeholder involvement in this activity Participants are introduced to how assessment using the IS assessment instrument works
4	Receive feedback	The presentation is followed by a question and answer session with participants. This is then followed by a group discussion of the IS assessment in general
5	Formulate, formalize and review IS assessment.	Describe the IS assessment variables Describe the IS assessment process Describe the IS assessment experimentation and expectations Collectively agree on the roles of each stakeholder in the assessment session Collectively agree on who is responsible for doing what
6	Identify variables for assessment	Stakeholders should discuss, identify and highlight the IS to be assessed, as well as the variables to be used during assessment To ensure successful assessment, attention should be given that all staff involved in the assessment are motivated to participate effectively by regularly demonstrating how the assessment is done to re-enforce recall Listening to participants and by regularly acting upon their recommendations One person should be identified to record the proceedings

Table 5.7: Script for the Assessment Mode (2)

No.	Task	Script Procedure
7	Set values for the variables to be used.	Having agreed on the variables to be used, the stakeholders should then discuss the values for these variables. They should set the variables giving reasons for the values and these should be recorded. These values are the input into the assessment process
8	Demonstrate how IS assessment is done Allow participants run experiments	It becomes easier for participants to get involved when a demonstration is given Participants are allowed to set up their own experiments and run them In the process, they discover new insights about their IS and IS assessment in general. This enhances their understanding, not only of the instrument but of their IS
9	Carry out the IS assessment	Participants are now ready to carry out IS assessment The results are recorded for future use and saved as well
10	Share results with other stakeholders	Participants save, export and publish their experiments over the Internet This enables other stakeholders share in the insights that the people that have attended the assessment gain This leads to organizational learning
11	Discuss the outcomes	Collectively discuss the meaning attached to the results Do they reflect the true picture of what has happened in the past concerning that particular IS In case they do, then the simulation results will create a sense of satisfaction that the trend is believable
12	Ending of IS assessment	Review the expectations of the participants and invite additional feedback which should then be documented Thank participants for their time

5.2 Verification and Validation

Before using the instrument, we needed to gain confidence in it by running a series of experiments.

Time period is set in years and run length is set at 8 years. We adopted 8 years as the average between the service life of a large IS and a particular component in that IS. The service life of a piece of equipment is defined as the total amount of use that the equipment can expend before its capability is degraded to the point where it must be replaced or undergo a major service life extension (Defense Science Board, 2008). The service lives are 12 years for the IS (Defense Science Board, 2008) and 5 years for components like PCs (Swanson and Enrique, 2000).

As seen above, we have component lifetime of 5 years and lifetime of a large IS is 12 years. To take into account that a developing country like Uganda has small to large IS, we arbitrarily took the average of 5 and 12 which gives 7.5 years. So 8 years was an arbitrary period since there were no documented records of the lifetime of systems in developing countries.

At startup, stocks were set to have a minimum value of zero, since stocks cannot be negative. STELLA (Ithink® 2007) software has inputs that are goal seeking, hence warm up time is deleted. This process of deleting performance data collected during warm - up is called the deletion procedure (Law, 2007).

Verification

As part of the verification, the following were done:

1. A walk through of the model was carried out to make sure that during the formulation process no variables are left out. Figure 5.11 is a screen shot of an error generated by the system during the walk-through highlighting a missing variable.

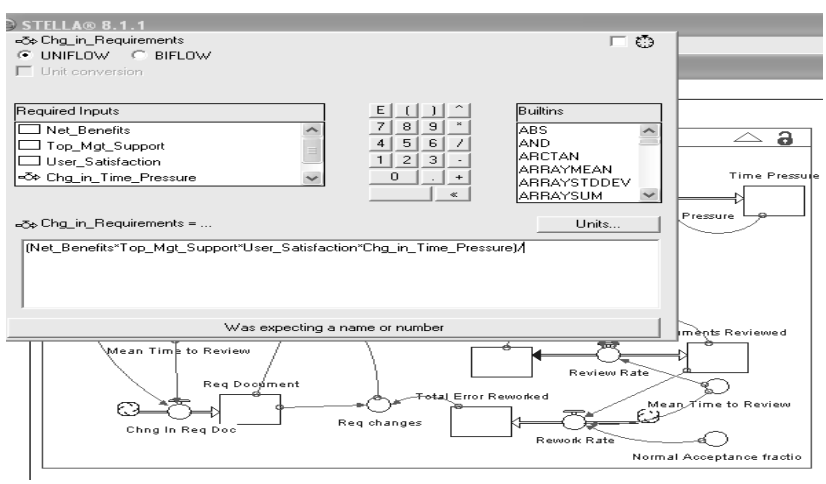

Figure 5.11: Screen Shot of an Error Message Generated due to a Missing Variable

Test simulation experiments were run for each sub-model and any errors corrected as illustrated in Figure 5.12

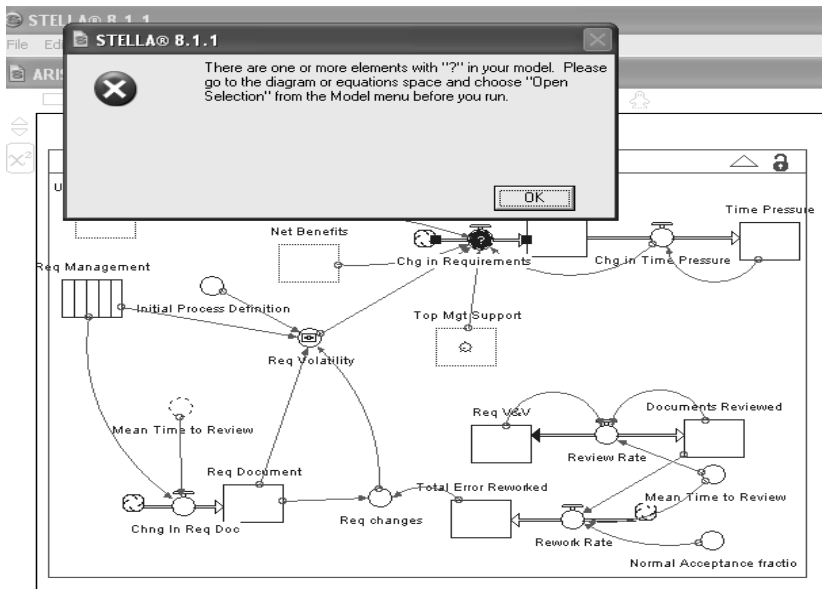

Figure 5.12: Screen Shot of an Error Message Generated due to Running a Simulation Missing a Variable

2. We eliminated what are known as 'dt' issues. The computation of a stock is approximated by a differential equation of the form:

$Level(t) = Level(t - dt) + (\Sigma InputRate - \Sigma OutputRate) * dt$

Where: 't' is the present moment in time, '(t-dt)' is the past moment in time, dt is the solution interval used in the model. In this study the time interval between the present moment in time and the past moment in time is done by progressively reducing the dt from 1 to the smallest value, 0.25; and documenting the results in table. There were no differences between the different dt values as illustrated in Table 5.8.

Table 5.8: Table Illustrating the Output for Different dt Values at Year 8

dt Value	Information Quality	User Satisfaction
0.25	8	8
0.5	8	8
1.0	8	8

3. We checked for any unexpected behavior such as negative stocks. This was done by animating all the stocks in the model and running some test experiments. No negative

stocks were found.

Validation

Validation answers the question whether the input-output transformation of the instrument, within its domain of applicability, has sufficient accuracy in representing the real system. Validation deals with building the right instrument (Semwanga, 2009; Sargent, 2007; Maani and Cavana, 2003; Coyle, 2000).

The instrument was validated by two methods, expert opinion and using sensitivity analysis. Ten experts from URA who have more than 3 years experience with IS and work in different IS knowledge areas, examined the instrument and expressed their confidence in its ability to assess IS success. seven of these managers have Msc Computer Science or IS and had simulation knowledge. They examined the instrument by first assessing its technical characteristics.
The experts drew some data from a system known as E-tax for input values for this test. During the simulations, the experts observed the output and expressed a level of comfort that the observed trend matched their knowledge of the system being simulated. Overall, the experts were pleased with the results they obtained from the instrument (see appendix D for the interview guide). The experts' responses are summarised below: 1. Asked about which input variables should be made available to a user of the instrument for assessing IS success, the following were identified: *accuracy, completeness, top management support, service quality, pressure to improve, requirements volatility, willingness to use the IS, influence of IS, greater control over one's work* and *access to timely/relevant information.*

2. On which 2 input variables were the most important, eight respondents were of the opinion that requirements volatility and top management support were the most important, while the other two were of the opinion that top management support and greater control over one's work were the most important.

3. Concerning sensitivity analysis, all respondents agreed that the behavior of the instrument mimiced the Etax system and that it potrayed a true representation of the system. They were alsoof the opinion that the instrument could be used to assess IS success in its current form.

An example of one such experiment is illustrated in Figure 5.13.

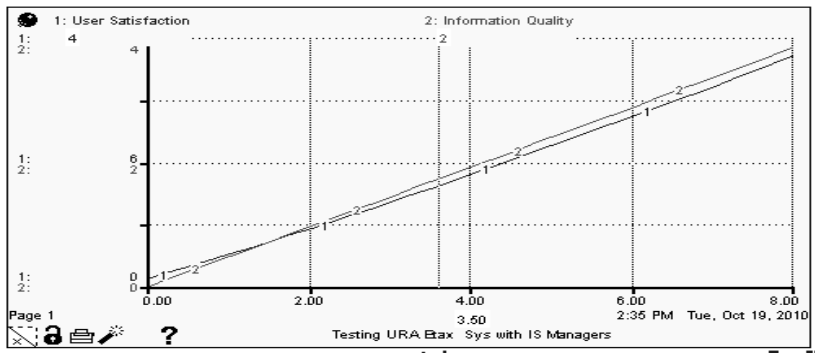

Figure 5.13: Screen Shot of one of the Sensitivity Tests Carried out with URA

Some of the detailed results are presented in the following tables 5.9 and 5.10.

Table 5.9: The Response of Information Quality to Changes in Requirements Volatility

Year	Req Vol at 2.5	Req. Vol at 2	Req. Vol at 1.5
1	0.46	0.58	0.78
2	0.93	1.05	1.23
3	1.82	2.28	3.02
4	2.21	3.98	4.46
5	3.44	5.00	5.06
6	4.00	5.13	5.37
7	4.70	6.31	6.67
8	5.00	7.32	7.46

Table 5.10: The Response of User Satisfaction to Changes in Requirements Volatility

Year	Req Vol at 2.5	Req. Vol at 2	Req. Vol at 1.5
1	1.18	1.21	1.25
2	2.07	2.14	2.23
3	3.49	4.11	5.2
4	4.71	5.0	5.67
5	5.20	6.17	6.55
6	6.02	7.31	7.70
7	7.03	8.09	8.25
8	8.14	8.69	8.99

Sensitivity analysis is a procedure to determine the sensitivity of a dependent variable to changes in the independent variable. If a small change to an input variable results in relatively large changes in the outcomes, the outcomes are said to be sensitive to that variable (Madachy and Boehm, 2008). This may mean that the variable has to be determined very accurately, and/or it has to be handled carefully in the real system, or possibly that the alternative has to be redesigned for low sensitivity. The modeler sets different input variable values to see how a change in the variable causes a change in chosen output(s). The IS success assessment instrument was subjected to a range of sensitivity tests to identify the parameters that have the most impact on the behavior and performance of the model. In this study, a systematic analysis was undertaken by increasing and decreasing parameters by 10% and examining the impact of these changes on key variables as indicators of IS success (Briggs *et al.,* 2006). For example we might show that by changing the requirements volatility by 10%, the information quality ratio falls by, say 90%. The type of sensitivity used is a one-way sensitivity analysis when one parameter is changed at a time.

STELLA (Ithink® 2007) software includes features for sensitivity analysis using a special dialog as illustrated in Figure 5.14.

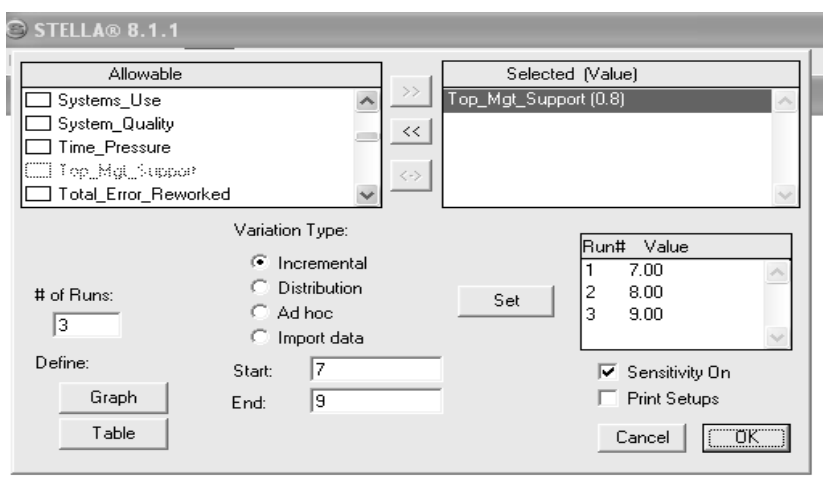

Figure 5.14: Sensitivity Analysis Dialog

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Top management support and requirements volatility were stressed by IS practitioners as two variables that are very crucial for the success of an IS, and normally affect the eventual outcome of an IS implementation. Top management support can be seen as

symbolic actions of support from top management. This often rallies other stakeholders to increase their involvement and support thus improving the chances of success of a given IS. Requirements like we have seen before, always change, but if the changes are so drastic, then this could jeorpadize the success of the system being implemented since there will be a lot of rework, time delays, increased costs and of course user dissatisfaction.

Our hypothesis is that if we increase top management support, we should obtain increased user satisfaction and vise versa. On the other hand, if we increase requirements volatility, we should observe a reduction in user satisfaction. The experiments described here sought to find out how these two variables affect IS success and the results helped in offering face validity for the instrument.
Table 5.11 presents a summary of the response of information quality and user satisfaction to changes in top management support.

Table 5.11: Summary Table of Information Quality and User Satisfaction with Top Management Support set to 3, 6 and 9

	Yr1		Yr2		Yr3		Yr4		Yr5		Yr6		Yr7		Yr8	
	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US
Top3	1	2	2	2	3	3	4	3	5	4	6	5	7	6	8	7
Top6	1	2	2	3	3	3	4	3	5	5	6	6	7	7	8	8
Top9	1	3	2	3	3	4	4	5	5	6	6	7	7	7	8	10

LEGEND:

Yr=Year

IQ=Information Quality

US=User Satisfaction

Top3=Top Management Support set to 3

From the extracted detailed results in table 5.11, it is apparent that as the level of top management support rises, the rate of user satisfaction and information quality also rises. The result is that for top management support set at 3, the user satisfaction attains a level of 5 out of 10 on the Likert scale at year 6. This can be compared with a level of 5 at year 5 when top management support is set to 6 and year 4 at a scale of 9; with all the other variables kept constant.

Another interesting result is that user satisfaction is seen to be more sensitive to top management support than information quality. This simulation supports face validity of the instrument in that it is logically consistent with what one would expect by simply

reasoning about user behavior. The user will be happy if the information quality rises as a result of increased top management support in tangible efforts like attending meetings, approving money for hardware, software and training of staff as well as purchase of other infrastructure.

Table 5.12 presents a summary of the response of information quality and user satisfaction to changes in requirements volatility.

Table 5.12: Summary Table of Information Quality and User Satisfaction with Requirements Volatility set to 2, 2.5 and 3

	Yr1		Yr2		Yr3		Yr4		Yr5		Yr6		Yr7		Yr8	
	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US	IQ	US
Req2.5	1	2	2	2	3	3	4	3	5	5	6	6	7	7	8	9
Req2	1	2	2	3	3	3	4	4	5	5	6	6	7	7	8	9
Req3	1	2	2	2	3	2	4	3	5	3	6	4	7	4	8	5

LEGEND:

Yr=Year

IQ=Information Quality

US=User Satisfaction

Req2.5=Requirements volatility set to 2.5

From the table 5.12, it is apparent that as the level of requirements volatility rises, user satisfaction is degraded. The result shows that when requirements volatility is set at 2, the user satisfaction attains a level of 5 out of 10 on the Likert scale at year 5. This can be compared with a level of 3 at year 5 and 5 at year 8 when requirements volatility is set to 3, with all the other variables kept constant.

From the table 5.12, it is apparent that as the level of requirements volatility is increased, the performance of the IS degrades further. It is apparent that the instrument depicts what happens in real life. The volume of changes is decided by requirements volatility, defined as the ratio of changed requirements (added, deleted, and modified) to total requirements. If these changes are too great, then this will impair the system as well as degrade the satisfaction of users. The simulation results from these three simulations also lend face validity to the instrument as seen with those for top management support.

In this study, sensitivity analysis was carried out by the researcher by changing the values of decision variables, to determine the most important variables that are very sensitive to small changes, in influencing IS success. Of all the variables that were used to test sensitivity, the instrument was most sensitive to requirements volatility, followed by top

management support.

From the experiments carried out in this study, we found out that the simulated outputs were generally very sensitive to requirements volatility followed to a lesser extent by top management support. The requirements volatility significantly influenced the simulated output for IS success. In particular, an increment in requirements volatility increased the number of years for the IS to attain success. On the other hand, a decrease in requirements volatility resulted in an improvement to predicted IS success.

The results of the sensitivity analysis are in agreement with expert opinion. The experts had indicated both top management support and requirements volatility as very important variables for IS success. This indicates that the instrument replicates the belief and knowledge of IS managers about their IS.

6. Testing the Instrument

In this chapter, we describe the evaluation of the instrument. The IS assessment instrument was designed based on the studio approach in chapter 4. We describe the evaluation approach followed by the evaluation of the instrument. The resulting information allowed us to determine whether the capability of the instrument in facilitating IS practitioners in assessing IS in developing countries.

6.1 Evaluation approach

According to Keen and Sol (2008), usefulness, usability and usage are key aspects of decision enhancement (see also Davis, 1989). The *usefulness* aspect addresses the value that the studio adds to IS assessment (Keen and Sol, 2008). The *usability* aspect looks at the extent to which a studio is perceived usable by the users, which includes the ease of interaction (Keen and Sol, 2008). The *usage* aspect relates to the actual application of the studio in the IS assessment (Keen and Sol, 2008). In this study, we used self-report usage (Adams *et al.,* 1992) which we refer to as potential usage. For purposes of this research, we interpreted the 3 U's as follows:

-Usefulness is the value that the studio adds to the assessment of IS.

-Usability is the extent to which the studio is usable by the users which includes the ease of interaction.

-Usage is the actual application of the studio in supporting IS practitioners in assessing their IS.

Evaluation Procedure

We organized for testing sessions after which questionnaires and informal interviews were conducted (see appendix E). We used the informal interviews to get more feedback from the respondents about their responses. The evaluation questionnaire comprised of three sets of questions: Yes/No questions, open-ended questions and closed questions arranged in a five point Likert scale to measure the respondents attitude to a given statement. The five point scale ranged from: *Not useful* (1), *Not sure* (2), *Fairly useful* (3), *Useful* and *Very useful* (5). Since the respondents were very few for each session (2-3) for the majority of sessions, e statistical analysis was not utilized as it would yield no added advantage.

Structure of the Testing Sessions

The users that participated in the testing sessions comprised of the experts and staff in the departments manning a particular IS as described in the subsequent sections. The users were formally informed of the testing sessions and appointments made with clear explanations of what was going to take place. A total of three sessions were held at each of the participating departments. Since there are only two variables displayed for all the sessions as explained in section 4.5, only two screen shots are presented here and the rest are presented in Appendix I.

6.2 Case 1 Makerere University

Makerere University is a national public university that was established on the 1st of July 1970. Since then, it has had a steady growth in the number of students as well as the number of undergraduate and post graduate programs being offered.
The Directorate for ICT Support (DICTS) is the body that is responsible for development and support for all administrative information systems in the University.
DICTS has been well accepted on campus, but they are somewhat short staffed, a combination of requiring specialized skills and lack of sufficient budget.

The information systems that they currently manage are:
1. Academic Records Information System (ARIS).
2. Human Resources Information System (HURIS).
3. Financial Information System (FINIS).
4. Library Information System (LIBIS).

In this case study, we carried out an assessment of two information systems:
i. Assessment of ARIS by ARIS staff.
ii. Assessment of ARIS by DICTS Managers.
iii. Assessment of HURIS by HURIS staff.

Case 1.1 Academic Records Information System-ARIS

The Academic Records Information System-ARIS is used to manage registration, payment of fees, and academic progress of all students within the University.

From a discussion with the participants, we learnt that ARIS was introduced in the 2008/2009 academic year. It is now fully utilized by all students who are now required to use it for registration purposes. The system is highly advantageous in terms of saving time and eliminating long queues that characterized the manual system. Another advantage attributed to the system is the cost of printing and photocopying, which was phased out as the system is now accessible on the University Intranet.

The most compelling advantage of the system according to participants, is the automatic capture and reflection of student payments so that ARIS staff do not have to deal with bank slips.

Nevertheless, the participants felt that the system had major constraints like the system being hard to use for a novice user and the numerous changes that are being thrown at the IT team all the time.

The first session, which involved training users, was carried out in the Senate Building with the CIO and 8 members of his staff. All the staff were information systems graduates and therefore had formal knowledge of information systems. The CIO on the other hand holds an MSc in Computer Science with modeling and simulation experience and teaches the subject at university. He thus made the discussion lively as he sought to learn more about the back end of the instrument and the relationships between the sub-models that make up the instrument. The modeling software was installed on each members laptop and a projector was used to project the instrument on the wall.

Before introducing the instrument, there was a lively discussion about information systems, information systems success and the assessment of information systems. The CIO supported the session by helping highlight areas of the instrument to the participants. After these discussions, the participants were introduced to the instrument and then led through the user manual. When everyone was comfortable with the instrument through sharing between the projected examples, the participants were able to follow by doing the same on their laptops, which made learning easier and faster.

It is after this that we opened the training screen and discussed the variables necessary for assessing IS success. The participants agreed that the variables selected were pertinent to assessing IS. Experiments were set up while sharing the exercise on the projected instrument. A number of experiments were run as a group, and then individually to reinforce learning. The results were saved on each laptop and the participants promised to keep on using the instrument and to learn more with time. They agreed to use the instrument for at least two weeks before running the second session, that is, how to communicate the results of assessment.

Two weeks later, we again gathered for the second session, the communication session. The instrument was opened on all the laptops and a copy was projected to the wall. The participants first observed the experiments that had been set up by the researcher and were shown how to navigate through the various screens of the instrument.

The participants run a number of experiments and observed the results of the IS assessment. The participants then shared the insights gained. Apart from projecting the instrument to the wall, the participants were shown how to save the results of experiments and how these can be shared over the Internet.

After the 5th week, the whole team converged again, to carry out session 3, to assess the ARIS system. The CIO and the staff in the department first experimented with the instrument by changing the values of the input variables and running simulations. They then shared the insights. This was followed by the CIO and staff, using the knowledge of ARIS system to agree on the scores to set for the input variables on the instrument.

Participants first experimented with the instrument by setting different values for the input variables as indicated in figure 6.1 and running simulations using the instrument. The participants then set the scores they felt represented the ARIS system.

The scores shown in the Table 6.1 were the result of the participants discussion :

Table 6.1: Input Values for ARIS Session 3

Number.	**Input Variable Name**	**Score**	Comments
1	Accuracy	4	Sometimes, you need to re-evaluate the outputs before giving the information out.
2	Completeness	2	Only 2 modules are fully functional out of the 6 modules leading to some information not being accessed.
3	Top Management Support	2	There is little support from the top management. ARIS Support is supposed to migrate information from Faculties into the College system. There is need for guidance but management does not fully appreciate the system. They also do not use the system directly.
4	Service Quality	9	The IT service personnel are very dedicated and competent.
5	Pressure to Improve	9	There is pressure from students and management.
6	Remuneration	2	This is very low. IT staff are not recognized and are treated as administrative assistants, hence very poor remuneration.
7	Requirements Volatility	2.5	Many changes are occurring to the structure of the University, calling for more changes in the system.
8	Willingness to Use the IS	2	The system is very difficult to use for a novice user as there are a variety of codes to use in order to access information. It is almost impossible for a layman to use it.
9	Influence of IS	8	The system has improved timely reporting, results, collection of money and reduced crowding.
10	Greater Control Over one's Work	8	The IT people and other ARIS people, are dependent on the system to accomplish their work.
11	Access to Timely/Relevant Information	8	This has tremendously improved with this system.

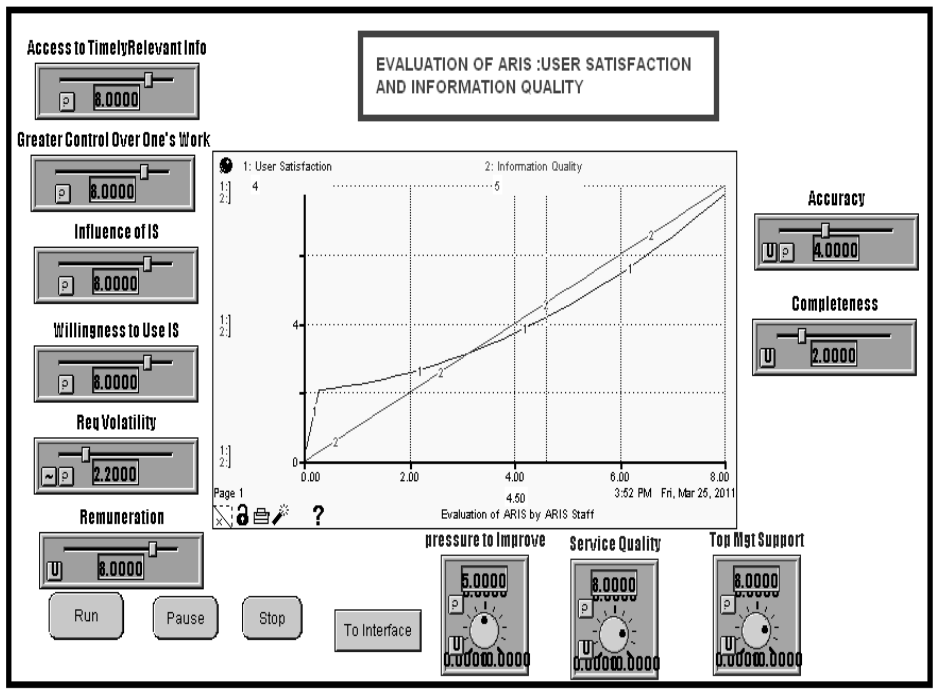

Figure 6.1: Simulation Result of ARIS Evaluation Showing the Result for Information Quality at 4.5 Years

Figures 6.1 and 6.2 graphically show how the level of information quality and that of user satisfaction vary as a result of the input values that were set by the ARIS staff.

The X-axis represents the number of years that are simulated.

From the simulation run after incorporating these values in the instrument (see table 6.1), we observe success using user satisfaction at year 5. On the other hand, using information quality, we notice success after year 4.5. The simulation results are shown in Figures 6.1 and 6.2.

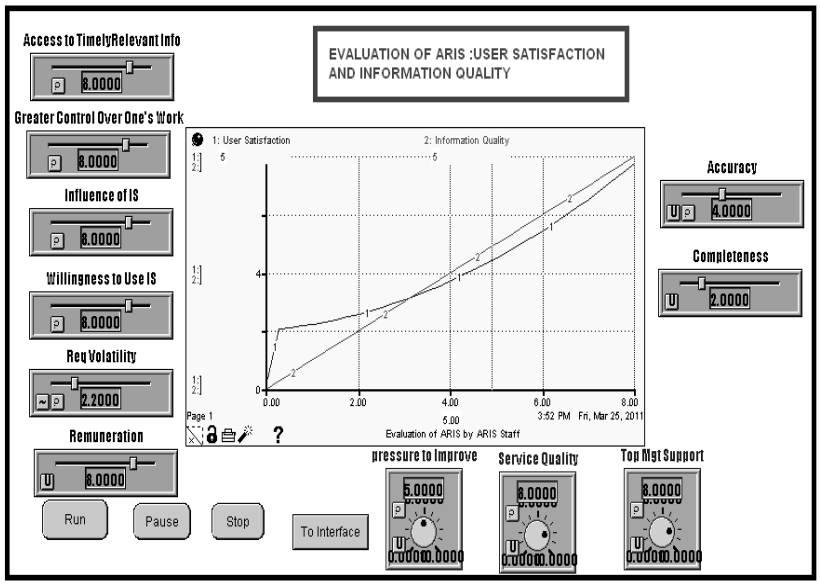

Figure 6.2: Simulation Result of ARIS Evaluation Showing the Result for User Satisfaction at 5 Years

Usefulness

After session 3, a questionnaire (appendix E), was administered to the participants to get their feedback on the usefulness, usability and usage of the instrument for IS success. The results are presented below:

Usefulness ARIS

All the staff were of the opinion that the instrument is useful for measuring IS success, the variables are relevant and the instrument captures all the factors associated with IS success. The majority, that is eight members of staff, were of the opinion that access to timely/relevant information was the most important variable for IS success, while 1 member was of the opinion that requirements volatility was the most important for IS success. All staff were of the opinion that the instrument was useful in representing the issues concerning IS assessment and as a communication tool to their fellow staff, as well as an aid to decision making.

When asked if the IS assessment instrument was useful, the participants responded in the affirmative with a lot of enthusiasm. The general sentiment was that it should be

adopted for use by ARIS staff. The respondents made it clear that the instrument facilitates the accomplishment of a number of objectives including bringing all staff together, information-sharing, contributing to organizational learning and raising awareness about the weak points in the information systems under their maintenance.

Some comments are given below:

"It makes assessment easier, when you are around the table with all your colleagues and the CIO, discussing your IS. You get to know some other issues that had never come to your attention before."

"It changes the way we now look at IS assessment. Everyone becomes involved and insights are generated as to what may have gone wrong and what could have been done to prevent problems. And this happens even before you start to run the simulation experiments."

"Recording the outcomes of the discussions is very important in that we will have always evidence and records to refer to in future."

"I feel that we are going to do a better job now since we are aware of the problem areas that need to be watched if we are to improve our information systems."

"The information-sharing as a result of discussion on a round table basis means that gaps in knowledge are filled. We end up with a more complete picture of what our IS entails and what is happening in the University. This is a unique opportunity to improve services campus-wide."

It was thus clear that the respondents viewed the instrument as invaluable in ensuring IS success.

Usability ARIS

From the questionnaire (Appendix E), the usability of the instrument was evaluated, with the following results presented below:

Question: Do you find the interface easy to navigate?

The majority of respondents, that is eight, found the interface easy to navigate and one was of the view that it could be improved.

Question: If you think it could be improved, how might it be improved?:

The respondent that was not comfortable with the interface was of the view that better navigation could be incoporated.

Question: What do you like most about the interface?

Two respondents stated that they liked the content, while seven indicated that it was understandability of the instrument they liked most.

Question: Is the interface easy to understand?
All the nine respondents concurred that the interface was easy to use.
Question: Explain your answer above.
Two respondents explained that the variables are clearly stated, four said that the interface is self explanatory, two said that the flow of information is good and the last one said that all the variables are on the same page.

From the responses of the respondents above, we can conclude that the respondents found the instrument usable.

Potential Usage ARIS

Seven participants were of the view that the instrument could easily be accepted for use in the IS assessment process of ARIS, while two were of the view that it would need to have more comprehensive discussions with management. On the issue of guidelines accompanying the instrument, two respondents were of the opinion that they greatly improve the IS assessment process, while seven found them beneficial. One respondent stated that using the instrument helped him very much in understanding IS success, while the remaining eight stated that it helped them. Six respondents reported using the instrument with others to try and solve IS issues as well as interpret them. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, six respondents reported having used it frequently, two regularly and one occasionally.

DICTS Evaluation of ARIS

Like we have stated before, DICTS is the body that is responsible for development and support for all administrative information systems in the University. It has a CIO who is deputized by one deputy director and a number of other managers who are responsible for system development, user training, E-learning platforms, networking and so many others. The CIO, her deputy and one other manager participated in the assessment of the ARIS System.
From a discussion with participants, we found out that DICTS faces many problems in carrying out their work. One of the problems cited was poor resource allocation and slow response when it comes to recruitment of staff. This, DICTS say is not only affecting ARIS, but other systems they manage as well. The other problems cited was the changing requirements, lack of awareness of users of some of the capabilities of systems as well as lack of data consolidation.

Before the first session could be held, participants wanted more clarification about the instrument and what it was supposed to do. In addition, the participants felt that another two variables: business processes and end user perception should be included in the instrument. End user perception is a well tested construct, so it was not difficult to model it in. On the other hand, business processes as a variable for inclusion, called for more literature search. We managed to model it in as well later after the meeting, thus making the instrument for DICTS unique from the other one used by other institutions. The two variables affected two influence diagrams: business processes, in conjunction with user resistance, affects top management support as seen in Figure 6.3; and user-perception affects systems use as seen in Figure 6.4.

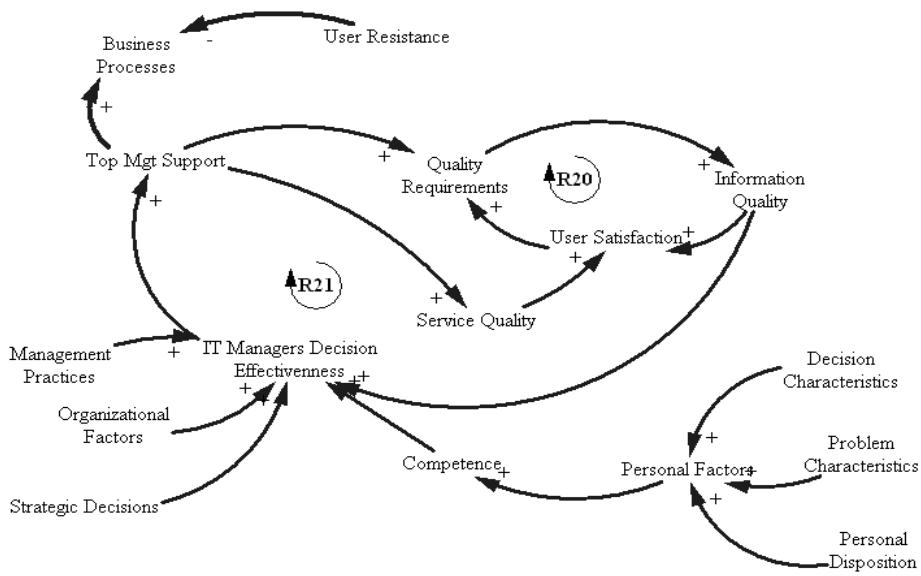

Figure 6.3: The Revised Top Management Influence Diagram for DICTS to Cater for Business Processes

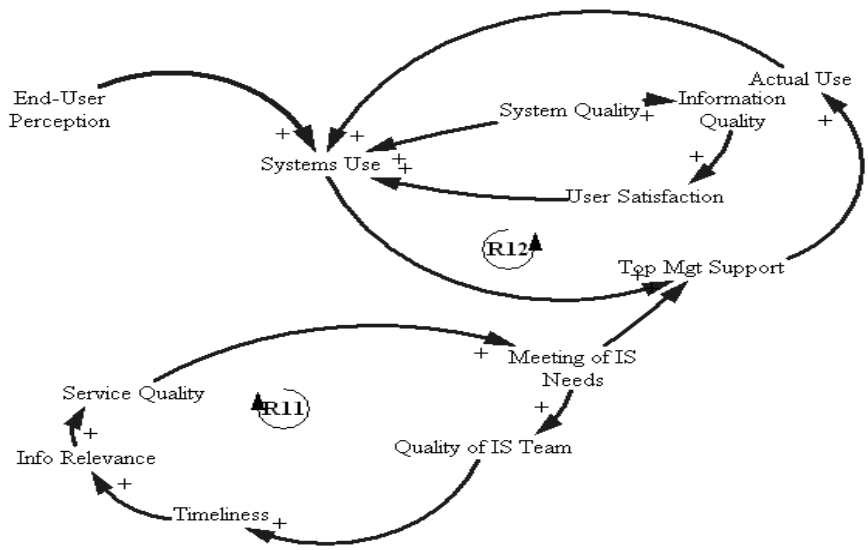

Figure 6.4: The Revised Systems Use Influence Diagram for DICTS to Cater for End-User Perception

The first session, which involved training participants, was carried out three weeks later in the Technology Building. All the participants were IS graduates and this provided a fertile ground for an interesting discussion about IS success. The instrument was introduced to the participants and they observed that the variables they had requested for inclusion were now included. The participants were led through the user manual and were very soon setting up experiments as a group using the instrument that was projected on the wall. The results were saved and the group went into another round of discussions. The participants felt that they were comfortable enough to try out the second session, that is, the communication session. The participants appreciated the idea of sharing experimental results over the internet as they saw that discussions can be followed through even though members were to be physically apart. The instrument was left with them for another 3 weeks to experiment with. At the end of the 3rd week, the whole team converged again and we proceeded to assess the ARIS system. The CIO and the staff in the department first experimented with the instrument by changing the values of the input variables and running simulations. They then shared the insights. This was followed by the CIO and staff, using the knowledge of the ARIS system to agree on the scores to set for the input variables on the instrument.

DICTS Results of Discussions

The values shown in the Table 6.2 were the result of the participants discussion:

Table 6.2: Input Values for ARIS as set by DICTS Session 3

Variable No.	Variable Name	Score	Comments
1	Accuracy	8	Fairly accurate, there are some integrity checks in place.
2	Completeness	5	Many potential outputs are not available.
3	Top Management Support	6	There is poor release of funds and recruitment of staff.
4	Service Quality	7	The professionalism of IT service personnel is very high.
5	Pressure to Improve	6	There is pressure from users.
6	Remuneration	6	The pay is average.
7	Requirements Volatility	3	There are many changes occurring to the system
8	Willingness to to Use the IS	8	Students are very eager to use the system as well as registrars.
9	Influence of IS	8	Users cannot do without it. Dependence of Academic Registrar's office is high.
10	Greater Control Over one's Work	4	Lack of data consolidation. You have to log into different locations sometimes getting conflicting results.
11	Access to Timely/ Relevant Information	5	Data exists in the central database, and there are interfaces to mine it. Access to the applications and facilities hinder accessing it in a timely manner.
12	End user perception	4	Lack of awareness by users in terms of what the system can do. Preconceived notions vis-avis reality. Users interact with a service so there is a a gap between the system and services because some aspects are not clear
13	Business processes	2	These are not well documented, not well understood, not optimally mapped and used.

Usefulness

One member of staff was of the opinion that the instrument is useful for measuring IS success, while two members were of the opinion that it was fairly useful. All the participants were of the opinion that the instrument, after incorporating business rules and end-user perception, captures all the factors associated with IS success. On the most important variable, two members were of the opinion that top management support was the most important, while one member was of the opinion that it is user satisfaction.

One participant was of the opinion that the instrument was very good at representing the issues concerning IS assessment, while two participants were of the opinion that it was fairly good. There was division on the instrument acting as a communication tool concerning information systems success with two participants having the opinion that it was useful, while one participant was not sure.
Two participants were of the opinion that the instrument was useful as an aid to decision making, while one participant was of the opinion that it was fairly useful.

The participants made extra comments as below:
" *I am surprised that we could be asked what is wrong with systems in Makerere! It is normal for people to heap the blame on DICTS when systems are not working to expectations, and yet there is a chain reaction due to wrong decisions being taken elsewhere. This is very different from what I was expecting.*"
"*Going through the process of preparing for assessment and discussing the systems openly has helped us visualize some of the bottlenecks we have not been concentrating on before.*"
" *The instrument almost replicates what we have observed on the ARIS system over the past 4 years. We hope the instrument can be adopted for use after the study.*"

Usability

From the questionnaire, the usability of the instrument was evaluated, with the following results presented below:
Question: Do you find the interface easy to navigate?
One respondent found the interface easy to use while the other two were of the view that it could be improved.
Question: If you think it could be improved, how might it be improved?
The respondents that were not comfortable with the interface were of the view that better navigation could be incorporated.
Question: What do you like most about the interface?
All the three respondents stated that they liked the content most.
Question: Is the interface easy to understand?
All the three respondents concurred that the interface was easy to use.
Question: Explain your answer above:
One respondent explained that the graphing is interesting and the various controls and buttons on the screen are well labeled and give a clear direction. Another stated that the interface is easy to understand with minimal explanation and guidance. The last respon-

dent was of the view that easy tutorials may be helpful. Question:Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?

All the three respondents concurred that this reduced information overload.

Question: In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?

One respondent said yes, the other participant confessed that there was not enough time to navigate through the entire instrument because of pressure at work.

Question: Is it easy for you to find what you want?

All three respondents stated that it was easy for them to find what they wanted.

We can conclude that the participants found the instrument usable.

Potential Usage

Two participants were of the view that the instrument could easily be accepted for use in the IS assessment process of ARIS, while one was not sure. On the issue of guidelines accompanying the instrument, all respondents were of the opinion that they greatly improve the IS assessment process as well as beneficial. One respondent stated that using the instrument helped him very much in understanding IS success, while the remaining two stated that it helped them. All respondents reported using the instrument with others to try and solve IS issues as well as interpret them. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, two respondents reported having used it regularly and one rarely, citing too much pressure at work.

Case 1.2 Human Resources Information System-HURIS

The human resources department of Makerere University is supposed to help in adequate utilization of human labor for productivity and attainment of the University's mission, goals and objectives. In an institution of higher learning, human resources form a primary resource, which is scarce, expensive and difficult to maintain.

From a discussion with the CIO and her deputy, we learnt that Makerere University spends over 70% of its financial resources on personnel emoluments, and thus, the University must concentrate its efforts on effective management of its employees for optimum returns on its investment in human capacity, giving a rise to the need of HURIS.

The human resources information system is used to manage both teaching and non-teaching staff within the University. The information from HURIS is used to plan short- and long-term staff requirements, help in recruitment of staff, job evaluation, training of

staff, carry out salary administration as well as pension fund administration.

The managers intimated that even though implementation of HURIS was supposed to be in May 2005, it was not until January 12th 2007, that it was commissioned. They argued that the plans for implementation were a bit unrealistic, hence the delays. In addition, release of funds for equipment, software and recruitment of staff is very slow and hard. As of now, the system is managed by just this team of two and back up comes in from South Africa, which sometimes creates problems.

The first session, which involved training participants, was carried out in the Main Building with the CIO and her deputy. The CIO and her deputy are both IS graduates and both are conversant with modeling and simulation. This made the training session an easy and short one. Both participants after being introduced to the instrument and having set up experiments and shared insights; requested that we carry out the second session. The second session was carried out immediately after and participants were very interested in the save-as option for sharing experimental results as files on the laptops and across the internet. It was agreed that we leave the instrument on both laptops and resume after 4 weeks.

After the 4th week, we converged again, to carry out session 3, to assess the HURIS system. The CIO and her deputy first experimented with the instrument by changing the values of the input variables and running simulations (see figures 7.7 and 7.8). They then shared the insights. This was followed by them, using the knowledge of HURIS system to agree on the scores to set for the input variables on the instrument.

The scores shown in the Table 6.3 were the result of the participants discussion :

Table 6.3: Assessment of HURIS

Variable No.	Variable Name	Score	Comments
1	Accuracy	8	The reports that are output from the system are accurate most of the time.
2	Completeness	8 8	The information that is output from the system is complete most of the time .
3	Top Management Support	4	Release of funds for equipment, software and recruitment of staff is very slow and hard.
4	Service Quality	6	Some of the service personnel come in from South Africa. Given the time and distance space, this creates problems.
5	Pressure to Improve	8	There is constant pressure from users as well as management for improvements in the system.
6	Remuneration	5	This is average.
7	Requirements Volatility	2	A lot of customization is going on because some of the modules are not working as expected.
8	Willingness to to Use the IS	2	Many of the staff have failed to master the system due to a closed mindset and resistance to change.
9	Influence of IS	5	You need to consult other databases like oracle to get complete reports
10	Greater Control Over one's Work	8	There is no need to consult others for one to carry out work.
11	Access to Timely/ Relevant Information	9	Staff have access to timely/relevant information within the department at all times when needed.

Usefulness

One participant was of the opinion that the instrument is very useful for measuring IS success, while the other one was of the opinion that it could be improved. Both participants were of the opinion that the variables used are able to help in prediction of IS success, as well as that the instrument captures all the factors associated with IS success. One participant was of the opinion that user satisfaction was the most important variable for IS success, while the other was of the opinion that requirements volatility was the most important for IS success. Both participants were of the opinion that the instrument was useful and was good at representing the issues concerning IS success. Both participants concurred that the instrument was useful as a tool for communicating issues concerning information systems success as well as an aid for decision making.

Usability

From the questionnaire, the usability of the instrument was evaluated, with the following results presented below:

Question: Do you find the interface easy to navigate?

One respondent found the interface easy to use while the other one was of the view that

it could be improved.

Question: If you think it could be improved, how might it be improved?

The respondent indicated that the navigation could be re-organized with the buttons a bit bigger.

Question: What do you like most about the interface?

Both respondents stated that it was the content they liked most.

Question: Is the interface easy to understand?

Both respondents concurred that the interface was easy to understand.

Question: Explain your answer above:

Both respondents explained that the variables were visible and understandable.

Question:Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?

Both respondents concurred that this reduced information overload.

Question: In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?

Both respondents said that this prevents committing of errors.

Question: Is it easy for you to find what you want?

Both respondents stated that it was easy for them to find what they wanted.

We can conclude that the participants found the instrument usable.

Potential Usage

Both participants were of the view that the instrument could easily be accepted for use in the IS assessment process of HURIS. On the issue of guidelines accompanying the instrument, both respondents were of the opinion that they greatly improve the IS assessment process as well as being beneficial for IS assessment. One respondent stated that using the instrument helped him very much in understanding IS success, while the remaining one stated that it helped her. Both respondents reported having used the instrument separately because of job pressures. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, both respondents reported having used it regularly.

6.3 Case 2 Barclays Bank

Barclays Bank is found in Kampala city and is one of the prestigious banks in Uganda. Barclays opened for business in Uganda in 1927 with two branches in the capital city, Kampala and one in Jinja, the country's second commercial center. In February 2007, Barclays completed the acquisition of Nile Bank Uganda Limited, strengthening its presence in the country to occupy 14.2% of market share. It now employs more than 1000 people, has 54 branches and 80 ATMs in service. Barclays corporate offers services to corporate clients with solutions for: Business foreign currency accounts, business loans, business current accounts, mortgages as well as online banking.

The corporate division is one of the critical areas of the Banks operation and coupled with the sensitivity of its operations like online banking, management is always pressuring the IT manager and his staff to deliver up-to-date reports about the business; because they want access to account information at all times.

The current system was implemented in 2009, and the online banking component was implemented in 2010.

The first session, which involved training participants, was carried out at their headquarters situated at plot 2 Hannington Road, Kampala, with the IT manager and two of his IT staff. The second session was carried out immediately after. The instrument was then left with the staff after the software was installed on everyone's laptop.

After the 3rd week, we converged again, to carry out session 3, to assess the Barclays Corporate system.

Participants first experimented with the instrument by setting different values for the input variables as indicated in Figures 7.9 and 7.10 and running simulations using the instrument. The participants then set the values they felt represented their own system.

The scores shown in Table 6.4, were the result of the participants discussion :

Table 6.4: Assessment of BARCLAYS CORPORATE

Variable No.	**Variable Name**	**Score**	Comments
1	Accuracy	9	The reports that are output from the system are accurate most of the time.
2	Completeness	9	All the modules are fully functional, thus the information that is output from the system is complete most of the time.
3	Top Management Support	9	There is a lot of support from the top management. The Bank is heavily customer driven.
4	Service Quality	9	The IT service personnel are very dedicated and competent.
5	Pressure to Improve	8	There is constant pressure from customers as well as management
6	Remuneration	9	Remuneration is very good and well above the sector average.
7 7	Requirements Volatility	1	Very few changes are occurring to the structure of the Bank leading to very few changes to the system.
8	Willingness to Use the IS	8	Staff say the system is easy to use and hence the majority is willing to use it.
9	Influence of IS	8	The system is seen as very instrumental in all the work that they do
10	Greater Control Over one's Work Over one's Work	9	The IT staff and other staff do not need to consult in order to work. This makes them very independent and effective.
11	Access to Timely/ Relevant Information	8	Staff have access to timely/relevant information within the Bank at all times when needed

Usefulness

All the three participants were of the opinion that the instrument is very useful for assessing IS success. They all agreed that the variables used are able to help in prediction of IS success and that the instrument captures all the factors associated with IS success. One participant was of the opinion that influence of IS is the most important variable for IS success, while the other two were of the opinion that it was accuracy of information that was the most important.

Two of the participants were of the view that the instrument was very useful, while the other one was not sure. One participant was of the opinion that the instrument was very good at representing IS success issues and the other two were of the opinion that it was

good. One participant felt that the instrument was very useful as a communication tool concerning IS success, while the other two were of the opinion that it was useful. Concerning the instrument as an aid to decision making, one participant was of the opinion that it was very useful, while the other two were of the opinion that it was useful.

The CIO had this to say in his personal capacity on the usefulness of the instrument "*Our company is heavily customer driven, hence the need to keep on upgrading our services by implementing new technologies. In many instances, before we face off with management to commit funds to IS, we are challenged to justify why we need more funding. This instrument would go a long way in educating all of us including top management and thus give us a common ground and understanding of our IS, leading to better decisions.*"

The respondents also stated that there are other risk factors arising form disputes and other unforeseen circumstances, like strikes and problems with contractors. They wondered if these could be included as variables in the instrument after seeing how handy the instrument could in prediction of IS outcomes.

Usability

From the questionnaire, the usability of the instrument was evaluated, with the following results presented below:

Question: Do you find the interface easy to navigate?

Two respondents found the interface easy to use while the other one was of the view that it could be improved.

Question: If you think it could be improved, how might it be improved?

The respondent indicated that the navigation could be re-organized.

Question: What do you like most about the interface?

Two respondents stated that it is the content they liked most, while the third stated that it was the understandability that he liked most.

Question: Is the interface easy to understand?

All the three respondents concurred that the interface was easy to understand.

Question: Explain your answer above:

Two respondents explained that the ease which information flowed from one party to the other made the interface easy to understand, while the third respondent stated that the interface had elaborate variables.When asked what he meant by this response, he stated that the variables made the IS assessment very clear that after the first time of use

subsequent sessions could be carried out with the original participants training the new ones without problems.

Question:Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?

All the three respondents concurred that this reduced information overload.

Question: In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?

All the three respondents said that this prevents committing of errors.

Question: Is it easy for you to find what you want?

All three respondents stated that it was easy for them to find what they wanted.

We can conclude that the participants found the instrument usable.

This shows that all participants found the instrument usable.

Potential Usage

Both participants were of the view that the instrument could easily be accepted for use in the IS assessment process of the bank. On the issue of guidelines accompanying the instrument, both respondents were of the opinion that they greatly improve the IS assessment process and that they were beneficial. One respondent stated that using the instrument helped him very much in understanding IS success, while the other stated that it helped him. Both respondents reported using the instrument together to try and solve IS issues as well as interpret them. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, 0ne respondents reported having used it frequently and the other regularly. We thus conclude, according to the users, that they were able to use the instrument in trying to understand IS assessment as well as using it to assess IS.

6.4 Case 3 National Water and Sewerage Corporation

National Water and Sewerage Corporation (NWSC) is a water supply and sanitation company in Uganda. It is 100% owned by the Government of Uganda. NWSC has the mandate to operate and provide water and sewerage services in areas entrusted to it, on a commercial and viable basis. The role of information systems in this endeavor, were thus stressed by the CIO. Currently, NWSC serves 17 towns including Kampala, Entebbe and Jinja, which are the major commercial areas. The CIO acknowledged that the biggest challenge faced by managers at NWSC is efficiently delivering services at an affordable

price. This calls for cost cutting, while at the same time making sure that services are still attractive and affordable to the citizens. The CIO sees the use of information systems as a means of reducing bureaucracy, increase in speed of work, and worker involvement; leading to increased self-confidence. To this end, the information systems department has taken on new innovations like E-water, where customers use their mobile phones to settle their water bills. This has led to the reduction and closure of many cash offices, which were a major source of revenue leakages. We carried out our testing at their headquarters situated at plot 39 Jinja Road, Kampala. The first two sessions were carried out with the CIO and 9 IT staff. The participants in NWSC were an interesting mix. Seven participants were IS graduates, was an accountant and another was a service agent. The accountant and service agent were not very conversant with the terms that are used in assessing information systems success. We were all assembled in the board room and the session took us about two hours explaining and discussing issues concerning IS success and how the instrument could be used to accomplish this. The instrument was projected to the white-board and everyone was free to contribute to the discussion. The participants were then trained on the instrument in the first session and everyone participated as the same instrument had been installed on the laptops of all the participants. The participants were guided through the user manual and after this, the participants decided that the second session is also run immediately. This was accomplished after another one hour and we agreed to meet again to assess four systems of NWSC after two weeks. The four systems were: Billing system, Accounting system, Call center and an in-house developed system. This gave us four test cases within one case.

CASE 3-1 NWSC Billing System

The billing system is the lifeblood of the organization. Management insist on having accurate and timely bills for the areas that NWSC is serving. The systems at all locations must be accessible to the billing staff at all times.

Participants first experimented with the instrument by setting different values for the input variables as indicated in Figures 7.11 and 7.12 and running simulations using the instrument. The participants then set the scores they felt represented the billing system. The values shown in Table 6.5, were the result of the participants discussion :

Table 6.5: Assessment of NWSC BILLING

Variable No.	Variable Name	Score	Comments
1	Accuracy	8	The system is accurate but sometimes accurate but sometimes the inputs are not accurate.
2	Completeness	10	The information that is input into the system is user defined and complete.
3	Top Management Support	9	Top management is well informed participative and supportive.
4	Service Quality	8	The professionalism of IT service personnel is very high.
5	Pressure to Improve	7	Management insist that they get precise reports, and yet some systems that are used to input into the billing system are not integrated with it.
6	Remuneration	7	IT staff are relatively well paid.
7	Requirements Volatility	2	Many changes have taken place due to demands for better service delivery and timely bills.
8	Willingness to to Use the IS	10	Without this system, people cannot work. This is the lifeblood of the organization.
9	Influence of IS	10	Initially, the system was manual with many errors. It has now changed the way people are doing their work and has improved timeliness of information.
10	Greater Control Over one's Work	8	Apart from new accounts, most of the work is routine. There are fewer issues that need consultation.
11	Access to Timely/ Relevant Information	10	In each location, all systems can be accessed at all times by authorized users. The system is robust as it has inbuilt redundancy.

Usefulness

One participant was of the opinion that the instrument is very useful for measuring IS success, while the other one was of the opinion that it was useful. Both participants were of the opinion that the variables used are able to help in prediction of IS success and that the instrument captures all the factors associated with IS success. One participant was of the opinion that greater control over one's work was the most important variable for IS success while the other was of the opinion that accuracy was the most important for IS success. Both participants were of the opinion that the instrument was useful for measuring IS success. One participant was of the opinion that the instrument was very good at representing IS issues, while the other one felt it was good. One participant was of the opinion that the instrument was very useful as a tool for communicating IS success while the other one took it as useful. Both participants were of the opinion that the instrument was very useful as an aid for decision making.

After the session, both respondents had this to say: "*We run leadership training programs both in-house and outside the country for middle managers and top-level executives, but we have never carried out any IS assessment exercise for the last 10 years and yet we spend a lot of money for IS. This instrument would really help us in this direction.*"
Both participants intimated that *most of the time management usually underestimate project costs which in the end puts a lot of pressure on the implementing departments.* They were of the view that a costing module would be very useful if it could be incorporated in the instrument.

Usability

From the questionnaire, the usability of the instrument was evaluated, with the following results presented below:
Question: Do you find the interface easy to navigate?
Both respondents found the interface easy to use.
Question: What do you like most about the interface?
One respondent stated that it is the content they liked most, while the third stated that it was the understandability that he liked most.
Question: Is the interface easy to understand?
Both respondents concurred that the interface was easy to understand.
Question: Explain your answer above:
One respondent explained that the understandability and navigation made the interface easy to understand. The other resondent was of the view that the variables were straight forward.
Question:Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?
Both respondents concurred that this reduced information overload.
Question: In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?
Both respondents said that this prevents committing of errors.
Question: Is it easy for you to find what you want?
Both respondents stated that it was easy for them to find what they wanted.
We can conclude that the participants found the instrument usable.

Potential Usage

One participant was of the view that the instrument could easily be accepted for use in the IS assessment process of the billing system, while the other felt that it could be discussed with other colleagues. On the issue of guidelines accompanying the instrument, both respondents were of the opinion that they greatly improve the IS assessment process. Both respondents stated that using the instrument helped them very much in understanding IS success. Both respondents reported using the instrument together to try and solve IS issues as well as interpret them. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, one respondents reported having used it frequently and the other one regularly.

CASE 3-2 NWSC Accounting System

The values shown in Table 6.6, were the result of the participants discussion :

Table 6.6: CASE 3-2-Assessment of NWSC ACCOUNTING

Variable No.	**Variable Name**	**Score**	Comments
1	Accuracy	9	Information is accurate and there are rare cases of complaints.
2	Completeness	9	Information is almost always complete.
3	Top Management Support	9	Top management is well informed participative and supportive.
4	Service Quality	8	The professionalism of IT service personnel is very high.
5	Pressure to Improve	7	Customers' demands keep on varying because of benchmarking with other organizations. Assignments caused by improvements in other systems that interface with accounting IS also cause pressure.
6	Remuneration	7	IT staff are relatively well paid.
7	Requirements Volatility	1	There have been very few changes.
8	Willingness to to Use the IS	7	Users are willing to use the system to a great extent because it makes the work easy.
9	Influence of IS	8	The system has improved timely reporting of results, collection of revenue and reduced crowding.
10	Greater Control Over one's Work	9	You do not need to consult anyone to carry out your work.
11	Access to Timely/ Relevant Information	7	Banks are the interface between the authority and its customers. The way they react to queries bogs down access to information in the system.

The in-charge of accounting and two other staff participated in the assessment of the NWSC ACCOUNTING. The accounting system manages all assets of the organization. The accounting system, designated SCALA, is supported on a Frame Relay platform with

a CISCO Routing platform for inter-office connectivity. Internet access to the entire WAN is supported securely through a CISCO PIX firewall in a tight NAT configuration. Participants first experimented with the instrument by setting different values for the input variables as indicated in Figures 7.13 and 7.14 and running simulations using the instrument. The participants then set the scores they felt represented the accounting system.

Usefulness

One participant was of the opinion that the instrument was very useful for measuring IS success, while two were of the view that it was useful. All three participants were of the opinion that the variables used are able to help in prediction of IS success and that the instrument captures all the factors associated with IS success. Two participants were of the opinion that requirements volatility was the most important variable, while the other was of the opinion that willingness to use the IS was the most important for IS success. The respondents intimated that user satisfaction as the success measure was the one that closely represented the accounting information system.

In a discussion with the respondents, they were of the view that if we could integrate the instrument with financial appraisal methods, then this would help bring top management on board since these always are comfortable looking at figures like Net Present value (NPV) and cash flows.

Usability

From the questionnaire, the usability of the instrument was evaluated, with the following results presented below:

Question: Do you find the interface easy to navigate?

Three respondents found the interface easy to use while the other one was of the view that it could be improved.

Question: If you think it could be improved, how might it be improved?

The respondent indicated that you could have better organization. Asked about what he meant, he stated that the buttons should be bunched together so that sliders appear on the other side.

Question: What do you like most about the interface?

Two respondents stated that it is the content they liked most, while the third stated that it was the understandability that he liked most.

Question: Is the interface easy to understand?

All the three respondents concurred that the interface was easy to understand.
Question: Explain your answer above:
Three respondents explained that whatever appears in the interface is clearly explained so one is able to make the right analysis. The other respondent stated that the variables displayed are straight forward, brief and precise.
Question: Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?
All the three respondents concurred that this reduced information overload.
Question: In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?
All the three respondents said that this prevents committing of errors.
Question: Is it easy for you to find what you want?
All three respondents stated that it was easy for them to find what they wanted.
We can conclude that the participants found the instrument usable.

Potential Usage

All participants were of the view that the instrument could easily be accepted for use in the IS assessment process, but could be more readily accepted if we were able to incorporate financial evaluation methods in it. On the issue of guidelines accompanying the instrument, two respondents were of the opinion that they greatly improve the IS assessment process, while the other one stated that they improved the process. All respondents stated that using the instrument helped them very much in understanding IS success. All respondents reported using the instrument with others to try and solve IS issues as well as interpret them. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, one respondent reported having used it frequently, and the other two regularly.

CASE 3-3 NWSC Call Center

The call center is supposed to serve as a one-stop center for responding to customer queries. The call center interfaces with other information systems and databases to retrieve information that is useful in responding to the customer queries in a timely manner. Participants first experimented with the instrument by setting different values for the input variables as indicated in Figures 7.15 and 7.16 and running simulations using the instrument. The participants then set the scores they felt represented the Call Center system.
The scores shown in Table 6.7, were the result of the participants discussion :

Table 6.7: CASE 3-3-Assessment of NWSC CALL CENTER

Variable No.	Variable Name	Score	Comments
1	Accuracy	7	Information is accurate to a large extent.
2	Completeness	8	When someone calls call center, some of the information has to be obtained from other sources.
3	Top Management Support	9	Top management is well informed participative and supportive.
4	Service Quality	8	The IT service personnel are very dedicated and competent.
5	Pressure to Improve	7	There is constant pressure from management to have quicker responses to customer queries.
6	Remuneration	7	IT staff are relatively well paid.
7	Requirements Volatility	1	Very few changes are occuring to the system
8	Willingness to to Use the IS	10	The system is very useful in responding to customer queries.
9	Influence of IS	8	When the system goes down, it is impossible to carry out any meaningful work.
10	Greater Control Over one's Work	8	Directions are well laid out on the menu, detailing how one can access information.
11	Access to Timely/ Relevant Information	6	Access to timely/relevant information is sometimes hampered as some information has to be retrieved from other sources.

Usefulness

All the three participants were of the opinion that the instrument is useful for measuring IS success. All the three participants were of the opinion that the variables in the instrument are able to help in prediction of IS success and that the instrument captures all the factors associated with IS success. All the participants were of the view that top management support was the most important for IS success.

One participant was of the opinion that the instrument was very useful for measuring IS success, while the other two were of the opinion that it was useful. All the three participants were of the opinion that the instrument was good at representing IS success issues as well as useful for communicating IS success. All the three participants were of the opinion that the instrument was useful as an aid for decision making.

The respondents from the call center were very interested in the communication component most. They asked if SMS could be incorporated with the instrument and integrated with their call center so that they could easily communicate with other colleagues in the process of carrying out their work, and not limited to assessment of IS.

Usability

From the questionnaire, the usability of the instrument was evaluated, with the following results presented below:
Question: Do you find the interface easy to navigate?
All the three respondents found the interface easy to use.
Question: What do you like most about the interface?
All the three respondents stated that it was the understandability that they liked most.
Question: Is the interface easy to understand?
All the three respondents concurred that the interface was easy to understand.
Question: Explain your answer above:
Two respondents explained that the interface was straight forward and this made the interface easy to understand. The other respondent was of the view that it was very clear.
Question:Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?
All the three respondents concurred that this reduced information overload.
Question: In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?
All the three respondents said that this prevents committing of errors.
Question: Is it easy for you to find what you want?
All three respondents stated that it was easy for them to find what they wanted.
We can conclude that the participants found the instrument usable.

Potential Usage

All participants were of the view that the instrument could easily be accepted for use in the IS assessment process of the call center. On the issue of guidelines accompanying the instrument, two respondents were of the opinion that they greatly improve the IS assessment process, while seven found them beneficial. One respondent stated that using the instrument helped him very much in understanding IS success, while the remaining 8 stated that it helped them. Six respondents reported using the instrument with others to try and solve IS issues as well as interpret them. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, six respondents reported having used it frequently, two regularly and one occasionally.

Case 3-4 In-house Developed System

NWSC has many information systems and databases. In order to mine these systems and databases, an in-house system was developed to ease report generation for management decision-making. The in-charge of the call center and two other staff participated in the assessment of the NWSC In-House Developed System. Participants first experimented with the instrument by setting different values for the input variables as indicated in Figures 7.17 and 7.18 and running simulations using the instrument. The participants then set the scores they felt represented the in-house developed system.
The scores shown in Table 6.8, were the result of the participants discussion :

Table 6.8: Assessment of NWSC In-House Developed System

Variable No.	**Variable Name**	**Score**	Comments
1	Accuracy	9	Information has a high level of accuracy
2	Completeness	9	The reports output from, the system have almost all the information needed.
3	Top Management Support	9	Top management is well informed participative and supportive.
4	Service Quality	9	The professionals of IT service personnel is very high.
5	Pressure to Improve	7	There is constant pressure from management to have quicker responses to customer queries.
6	Remuneration	7	Staff is general well paid.
7	Requirements Volatility	2	There are moderate changes occurring to the system
8	Willingness to to Use the IS	8	Users are willing to use the system to a great extent.
9	Influence of IS	8	Users are beginning to appreciate the outputs from the system.
10	Greater Control Over one's Work	8	Users may want to use some aspects of the system but some of these are missing to a lesser extent.
11	Access to Timely/ Relevant Information	5	The system is not very flexible, since the system is still being developed and standards are not yet in place.

Usefulness

One participant was of the opinion that the instrument is very useful for measuring IS success, while the other one was of the opinion that it was useful. Both participants were of opinion that the variables used are able to help in prediction of IS success, as well as that the instrument captures all the factors associated with IS success. One participant was of the opinion that top management was the most important variable for IS success while the other was of the opinion that requirements volatility is the most important.

Usability NWSC In-house Developed System

From the questionnaire, the usability of the instrument was evaluated, with the following results presented below:

Question: Do you find the interface easy to navigate?

Both respondents found the interface easy to use.

Question: What do you like most about the interface?

One respondent stated that it was the understandability he liked most, while the other stated that it is the content he liked most.

Question: Is the interface easy to understand?

Both respondents concurred that the interface was easy to understand.

Question: Explain your answer above:

One respondent explained that the interface was simple and easy to understand. The other resondent was of the view that all variables displayed are straightforward.

Question: Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?

Both respondents concurred that this reduced information overload.

Question: In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?

Both respondents said that this prevents committing of errors.

Question: Is it easy for you to find what you want?

Both respondents stated that it was easy for them to find what they wanted.

We can conclude that the participants found the instrument usable.

Potential Usage

One participant was of the view that the instrument could easily be accepted for use in the IS assessment process of the in-house development section most especially for the systems that are being developed by the team, while the other one was of the view that the instrument should be used for all systems in NWSC. On the issue of guidelines accompanying the instrument, both respondents were of the opinion that they greatly improve the IS assessment process. Both respondents stated that using the instrument helped them very much in understanding IS success. Both respondents reported using the instrument together to try and solve IS issues as well as interpret them. No respondent experienced any technical problems while using the instrument. On using the instrument during the time when it was left to them, both respondents reported having used it

frequently.

Summary of Findings

Tables 6.9, 6.10 and 6.11 present the summary of findings from the testing sessions

Table 6.9: Summary Assessment of Usefulness of the Instrument by Respondents

Question	Responses	Frequency
In your opinion, how do you rate this instrument?	Very Useful	8
	Useful	19
	Fairly Useful	1
	Not sure	3
	Not useful	0
Representation of IS success issues in the instrument	Very Good	7
	Good	18
	Not Sure	0
	Fairly Good	2
	Not at all Good	0
Communication tool concerning information systems success	Very Useful	7
	Useful	19
	Fairly Useful	0
	Not sure	1
	Not useful	0
Aid to IS Managers for Decision Making	Very Useful	9
	Useful	16
	Fairly Useful	2
	Not sure	0
	Not useful	0

Table 6.10: Summary of Usability Testing of the Instrument by Respondents

Question	Responses	Frequency
Do you find the interface easy to navigate?	No problems	20
	Could be improved	7
If you think it could be improved how might it be improved?	Better navigation	6
	Reorganized	1
What do you like most about the interface?	Color	0
	Content	8
	Understandability	19
Is the interface easy to understand?	Yes	27
	No	0
In your opinion, does the interface prevent the user from making common errors like deleting icons/keys?	Yes	25
	No	1
	I did not get enough time to navigate the instrument as I was busy.	1
Is it easy for you to find what you want?	Yes	26
	No	1

Table 6.11: Summary of Assessment of Potential Usage of the Instrument by Respondents

Question	Responses	Frequency
In your opinion, can the instrument be easily accepted for use?	Yes More discussions are needed with management	24 3
In your opinion,do the guidelines accompanying the instrument? improve IS assessment?	Greatly improve Beneficial	18 9
Using the instrument helped in understanding IS issues	Helped very much Helped	7 20

6.5 General Observations

Valid inferences can be drawn from the findings presented in sections 6.2, 6.3 and 6.4. Earlier research by Nielsen (2000) had indicated that a sample size of 5 was enough to uncover 98% of usability problems, but subsequent research by Faulkner (2003) reveals that better results can be achieved with a sample from 5-10. Increasing the number tested to 20 can allow practitioners to approach increasing levels of certainty that high percentages of existing usability problems have been found in testing.

After testing, we had informal interviews with the respondents, which enabled us to learn more about the application of the instrument. After the informal interviews, we felt that the findings were sufficient for this research since they brought out the relevant information on the applicability of the instrument for IS assessment. This is because the instrument was found easy to learn and use and was deemed appropriate for assessing IS of the respondents choice. The following insights were derived from the results of testing the instrument:

Training Mode

All respondents were of the opinion that guidelines accompanying the instrument helped very much in understanding IS success.

In the open-ended questions, respondents were asked about what they liked most about the instrument, the majority felt that the understandability of the instrument was what they liked most while the others felt that it was the content in the instrument that they liked most. All the respondents were happy with the interface, saying it was easy to

understand. Most of the respondents found it easy to navigate the instrument, whereas a few were of the view that it could do with better navigation, with navigation buttons arranged next to each other. One respondent was of the view that it could be re-organized with sliders being located on one side while radio buttons are on the other. The majority of the respondents were happy with the fact that with navigation buttons in place, it prevented users from deleting icons and other useful components on the instrument. They were also happy that the facility of Undo and Redo was available, which increases confidence as the users continue to use the instrument.

Regarding whether respondents had problems using the instrument to assess IS, all the respondents reported that they did not experience any problems. All respondents thought that the instrument was easy to use after getting initial training and running some simulation experiments. These observations have direct implications for the learning curve of using the instrument in the actual assessment of IS.

Communication Mode

Most respondents were of the opinion that the instrument is very useful in communicating IS success and thus very useful for decision-making.

The respondents that interact a lot with customers were very receptive of the communication component of the instrument and felt that incoporation of SMS could enhance their work.

Assessment Mode

Most respondents were of the opinion that going through the process of preparing for assessment and discussing the systems openly helps practitioners visualize bottlenecks they were not focusing on before.

Most of the respondents were very positive about the usefulness, usability and usage of the instrument for IS success. The respondents gave positive remarks such as, the instrument making the assessment easier and quicker while using the instrument. They also stated that using the instrument helped them very much in understanding IS success. We can therefore infer that the respondents attitudes towards the facilitation provided by the instrument in IS assessment were very positive. We can conclude that as observed through these case studies, the ISASSI instrument improves the support provided for assessing IS

success in developing countries.

It was observed that recording outcomes of discussions on a round table basis means that gaps in knowledge are filled and practitioners share a common understanding.
We can infer that the overall perception among respondents was that the instrument was considered to be important for IS assessment in developing countries, and that the functionalities provided in the instrument for IS assessment can be used in a variety of organizations in developing countries.

Some of the other issues arising after using the instrument to assess information systems included: an inclusion of a costing tool to enable better decision-making before approval of projects; inclusion of financial IS evaluation methods; inclusion of risk variables and incorporation of an SMS component to improve communication. For purposes of this research, we considered these issues to be non-core and decided to treat them as recommendations for improvements to the instrument.

The case studies revealed that the respondents were very positive about the contribution of the instrument in assessing information systems as indicated in the findings presented in sections 6.2; 6.3 and 6.4 and tables 6.9, 6.10 and 6.11. Some of the respondents were eager to have fully operational functionality, such as that implemented in the instrument, as soon as this research is complete, so that they can start using it in assessing their information systems.
The insights in this section were derived from the evaluation of the instrument and its supporting guidelines oh how to use it presented in these sections 6.2; 6.3 and 6.4.

6.6 Conclusions

This chapter presented details of the evaluation that was carried out on the ISASSI instrument and its supporting guidelines on how to use it in providing enhancement to IS assessment. The evaluation followed recommendations given by Hevner (2007), concerning the introduction of the instrument to the respondents. The aim of carrying out tests was to assess the use of the instrument in improving IS assessment in developing countries.

From the study findings and the testing of the instrument, factors that aid in improving the prospects of successful IS projects appear to be the same for developed and developing countries. But there is a marked difference in how these affect IS in the developed and

developing countries. This was explained by the fact that whereas top management support and requirements are handled well in developed countries, in developing countries, in the majority of the organizations, top management does not understand IS and sometimes withholds funds meant for IS. In addition, projects take too long, with requirements changes running out of control in the majority of cases. Thus, the context in which IS are implemented is very important in determining the factors that need to be observed critically during IS implementations.

Through the case studies, we were able to learn that the instrument enabled the IS practitioners to forge a common understanding of IS success and IS success issues. They were able to discuss freely the various challenges they face concerning their IS, leading to greater insights than had not been imagined before the test sessions were carried out.

The qualitative observations drawn from the case study showed that the participants had a positive evaluation of the instrument. The stakeholders appreciated the use of ICT in assessing information systems of their choice. The concept of the studio-based approach to facilitate IS assessment in developing countries was considered to have been successfully tested and established. We can conclude that the testing of the instrument and the case study objective were achieved by collecting feedback on usefulness, usability and usage.

7. Epilogue

In this research, we recognized that information systems are indispensable in the life of organizations world wide most especially in developing countries which lag behind on all fronts. However, documented failures of IS implementations are very common in developing countries leading to losses of scarce capital. The objective was to develop a solution to aid in sustaining working information systems over long periods of time in developing countries. In this chapter, we reflect upon the research, discuss the research findings, generalizability of the research and provide directions for further research.

7.1 Research Findings

In this section, we present the research findings, discuss the achievement of the research objective and provide answers to the research questions.

Achievement of the Research Objective

The main objective of the research was:
To develop an approach to improve the prospects of IS success in developing countries.

We used the inductive-hypothetic strategy in a design science philosophy to explore the area of research and to test the instrument, and we concluded that the empirical evidence gathered suggests that the research objective was realized. This is based on the fact that through the case studies, we wanted to study situations under which the instrument is useful and can improve IS implementations, and not to study the differences between case study subjects. In this testing phase we used three cases and we arrived at similar findings. The instrument was used and evaluated by stakeholders in information systems who found it to be useful and usable in that it helped to predict the likely consequences of actions in implementing information systems. The results obtained and presented in chapter 6 indicate that a lot of insight about their implemented systems was greatly improved as a result of their interaction with the instrument. We therefore conclude that the objective was achieved.

Research Questions

The research was aimed at providing a solution to aid sustain working information systems over long periods of time in developing countries. There was need to study the main issues and challenges to be considered in providing such a solution. To enable us achieve this, we formulated a main research question as follows:
What are the issues influencing information systems success in developing countries and how can we design an approach to improve the prospects of IS success?

The research question was aimed at enabling us come up with an instrument that could be used to improve and ensure the implementation of information systems in developing countries. The research question was partly answered in chapter one, and further elaborated in chapter two. In this research, we suggest that Decision Enhancement Services provide support to improve IS assessment in developing countries.
We carried out an exploratory case study to help us identify the issues to consider and the challenges to be met when developing an instrument to assess information systems in developing countries. The exploratory case, carried out in Uganda, revealed the following:

- Lack of top management support-in most of the organizations, the organizational culture is geared towards obeying the boss without question. Coupled with this, there is lack of top management support occasioned by lack of knowledge on the part of management of IS related issues. Internal politics when not checked also leads to poor decision-making. This makes it difficult to provide a solution that can be embraced by all stakeholders.

- Lack of involvement of IS stakeholders-many stakeholders are side-lined when decisions about IS are being undertaken. Some of the critical decisions are taken by non IS practitioners.

- Lack of knowledge and appreciation of IS. Many of the available methods used for appraisal are financial and most IS stakeholders are deficient in finance and accounting. In addition, most of these methods are very complicated to use, while the stakeholders have diverse backgrounds.

- Lack of a clear process for IS assessment-in most organizations, there is no clear process for IS assessment and no formal IS assessment has ever taken place for years.

These issues make it necessary to provide support to improve and facilitate the implementation of information systems and sustain them for long periods of time. This would ensure that all stakeholders are knowledgeable about IS success issues, problem areas and how to improve IS success.

Poor implementation of IS will have a negative economic impact as scarce resources will be lost. This is more critical for developing countries that are not economically empowered. These findings are in line with findings by Avgerou (2008); Ikem (2005) and Heeks (2000).

In this section, we explain how the IS assessment instrument can enable the improvement of IS implementations in developing countries if appropriately deployed. The IS assessment instrument made IS practitioners aware of the role played by ICT-enabled interventions for IS assessment in developing countries.

Research Question 1

To assist in analyzing the issues that were presented earlier, we studied literature on IS success with the aim of learning how we could improve IS implementations. The research question supporting this line of inquiry was formulated as:

What theories can be used to explain IS success?

This research question dealt with the relevant issues regarding solutions that are currently used or can be used for the purpose of assessing IS. We carried out a literature review to learn how the existing theories could be applied to come up with a solution for developing countries. In chapter 2, we discussed that the dominant theories in IS success that are used in the developed countries did not cater for some of the challenges in developing countries. We pointed out that one of the challenges in developing countries was lack of knowledgeable staff, this calls for a simple to use solution for IS assessment. Most of the theories were complex and thus difficult to adapt to the developing country context.

Another challenge identified was that early attempts to define information systems success were not successful due to the complex, interdependent and multi-dimensional nature of IS success (Petter *et al.,* 2008).

The case study we carried out revealed that it is challenging to carry out IS assessment

due to the constantly changing requirements, lack of top management support, lack of knowledge and a host of others.

Since the current theories were unable to provide a solution for IS assessment in developing countries, there was need to extend the DeLone and McLean (2002) theory to provide this solution. Basing on work done by Semwanga (2009) and Williams (2002), we developed an IS assessment instrument to facilitate and improve the implementation of information systems. The IS assessment instrument which consists of a single suite developed in the course of this research, is based on System Dynamics and is the main contribution of this work.

Research Question 2

After reviewing the challenges involved in developing a solution for improving IS implementations in developing countries, the next issue that was addressed in this research was the requirements that were required to enable us design the suite to facilitate IS assessment. The second research question was formulated as:

How should a solution for ensuring IS success in developing countries look like?

As discussed in chapter 2, in order to provide supporting tools to aid stakeholders in their decision-making, decision enhancement was adopted (Keen and Sol, 2008). In such a setting, suites are deployed in a studio, using experimental process methods and recipes on how the stakeholders can interactively use the deployed suites.

The IS assessment process involves many actors with differing backgrounds and needs, thus the suite is a necessary medium for their use for assessing IS.

Six requirements were formulated for the functionality of the suite based on the case study and findings from the literature. Satisfying these requirements resulted in a suite that facilitates and improves the implementation of IS in developing countries. The requirements were focused on the three dimensions of usefulness, usability and usage of the suite in facilitating the IS assessment process.

Research Question 3

After understanding the challenges surrounding IS success and the current solutions, the next issue was to look at ways to improve IS implementation in developing countries. The guiding question for this part of the study was formulated as follows:

How can we develop a solution for ensuring IS success in developing countries?

For developing a solution for ensuring IS success in developing countries, we used the "four ways of" framework (Van de Kar, 2004; Sol, 1988). The *way of thinking* (see section 4.2) describes how we observe organizations, information systems and how these are implemented. Decision enhancement services and studio principles are very appropriate in a setting of multi-actor, multi-faceted, that is characteristic of information systems. The *way of controlling* looks at the means and ways of using the instrument (see section 4.3). The *way of working* specifies the steps that are taken in using the instrument (see section 4.4). The *way of modeling* involved the diagramming technique to create the model that supports the instrument (see section 4.5). Chapter 5 presents the suite as an instrument for assessing IS in developing countries.
The suite was conceptualized using ideas taken from Semwanga (2009) who stated that the beneficiaries of a suite are the stakeholders involved in the problem area where you want to provide the solution. The functionalities of the suite were developed in such a way that they correspond to the requirements of IS assessment in developing countries, namely:

- Involving all stakeholders in the IS assessment process.
- Provision of training to all stakeholders.
- Enable communication of assessment results to all stakeholders.
- Enable a well organized IS assessment process.

We state that a solution to improve IS success needs to encompass all the above attributes. The instrument that was developed provides adequate functionality that represents the IS assessment situation in an organization. It incorporates the main variables related to IS success and improves the IS assessment process. We developed an IS assessment instrument representing these four components which were broken down and translated into three modes that closely matched, and provided the functionality required to fulfill IS assessment for developing countries.

Research Question 4

The instrument had to be tested in a developing country context to determine whether it provided the required support and facilitated IS assessment that met stakeholder needs. We wanted to test the instrument in a developing country context to determine whether its application facilitated IS assessment as required by IS practitioners. The guiding research question for this part of the study was formulated as follows:

How can we evaluate the solution to provide support to IS managers in developing countries to ensure IS success?

The instrument works by users selecting an IS of their choice, setting values for variables they want to run simulation experiments and then assess the IS. The instrument was tested on the three dimensions of usefulness, usability and usage in a case study setting. Training formed the starting point for running the functionality of the instrument. This was carried out using a laptop and projector. The second functionality of communication relies on the Web, where the results from simulation experiments are posted on the Web and can thus be shared by all stakeholders having internet connectivity. The IS assessment functionality has an in-built graph that aids users to set up simulation experiments and observe the reaction of the output variables over time, as they make changes to the input or decision variables.

The case study incorporated stakeholders in the empirical testing procedures to gather direct feedback on their experiences of using a suite to deploy an instrument for assessment of IS. The aim of conducting the tests was to study whether it facilitates the IS stakeholders in assessing IS and whether it improved their decision making. Details of these tests were shown in section 6.2; 6.3 and 6.4.

The information presented in chapter 6 enabled us to conclude that the instrument for assessing IS provided the users with enough functionality to enable them assess IS of their choice in developing countries. The findings indicated that, on a whole, the stakeholders valued the usefulness and usage of the IS assessment instrument. We can conclude from the data that the IS stakeholders were comfortable working with the instrument. Stakeholders also expressed satisfaction with the instrument as an aide to their decision-making.

Based on the tests we carried out, we were strongly convinced that the use of the instrument improves the assessment of information systems in developing countries. The IS assessment instrument through its three modes of *training*, *communication* and *IS assessment* supports stakeholders in the IS assessment process. We were strongly convinced that the usefulness and usability of such a suite could be generalized to fit any developing country context. We tested the suite in Uganda, a developing country, but we also state that it can be applied to other developing countries that have similar characteristics like those in Uganda for the following reasons.

The evaluation results presented in chapter 6 reveal that participants' perceptions towards the usefulness of the IS assessment instrument were positive. We obtained similar findings for the three case study organizations which indicates consensus from the different stakeholders.

The training mode facilitated stakeholders in appraising themselves of IS success issues, on how the instrument works and provided a common understanding for all participants.

The communication mode was instrumental in sharing information about the assessed IS and insights gained.

The assessment mode facilitated participants in generating debate about their IS and assessing the given IS leading to greater insights.

From the evaluation results, it seems to pay to use the instrument in assessing information systems. The results showed most respondents rated it highly on all items related to its usefulness in IS assessment. It also seems that the usability and usage of a suite in assessing information systems may be greatly determined from what the users of the instrument considered as its usefulness, because those users that rated the instrument as useful, rated it as usable and reported having used it in their spare time.

The fact that the respondents were able to select a given IS, determine the scores for the given variables and run simulation experiments to assess the IS, we can say that this had a positive effect on their attitude to their perceived usefulness of the instrument in facilitating the assessment of information systems

7.2 Research Approach

In this section, we reflect on the research methodology. The research approach consisted of: a research strategy
a research philosophy
and research instruments.

Research Philosophy

The research philosophy used was design science, since we considered the research problem to be ill-structured (Hevner, 2007). The scientific contribution of this work comes through the development of a design artifact and test its utility in improving the existing situation, thereby adding value to the practice of developing ICT solutions for developing countries. Following Weber, Lin and Trauth and Jessup (Weber, 2004; Trauth and Jessup, 2000; Lin, 1998) the choice of research perspective was a complement of both the positivist and interpretive since we were dealing with both people and information systems.

In section 1.3, we presented the research objective to develop an approach to improve the prospects of IS success in developing countries. Epistemologically, design science strives to create innovative and valuable artifacts. A researcher using design science attempts to create things that serve a human purpose (Land *et al.,* 2009). The outputs of design science are assessed for their usefulness (Winter, 2008; Iivari, 2007). The way we addressed the research objective was to develop a model, a studio as well as guidelines for its use, that is an artifact. We obtained knowledge about IS assessment in developing countries by studying applications of the IS assessment instrument in assessing IS through three case studies.

The goal of the work was to facilitate and improve the implementation of information systems to enable them stay in service for a long time. We state that the work was useful (Iivari, 2007) and served a human purpose (Land *et al.,* 2009) thereby supporting our choice of design science as an appropriate research philosophy for this work.

Research Strategy

The problem we studied in this research exhibited characteristics of an ill-structured problem because the alternative courses of action for providing alternative courses of action

for providing solutions were unlimited (Sol, 1982). This is because a great number of alternative solutions could be thought of to provide support for the IS assessment process in developing countries. Considering the complex, interdependent and multi-dimensional nature of IS success, there was probably no solution available that could be relied upon to support IS stakeholders this way.

The IS assessment instrument we developed consisted of three modes; one for training staff, another for communication and the third for assessment of IS. As a means of understanding the problem in detail before setting out to develop the instrument, we carried out an exploratory study. The aim of carrying out the exploratory study was primarily to formulate or elaborate a theory rather than to test the theory. The exploratory case study enabled us to develop a descriptive model of the research challenges and to formulate the requirements for solving the challenges we had observed.

Research Instruments

As stated by Muniafu (2007), the selection of research instruments depends on the amount of existing theory available, on the nature of the research and on the type of research question. We used several instruments to implement the research strategy. We used exploratory research to determine the actual issues to be handled in IS assessment in developing countries, to determine the requirements for the functionalities of the suite, and to understand the significance of providing support tools to improve and facilitate the development of an instrument for assessing information systems.

Generalizability of the Research

Generalizability refers to the degree to which research findings are applicable to other populations or samples (Falk and Guenther, 2006; Ryan and Bernard, 2000). It involves the usefulness of one set of findings in explaining other similar situations (Falk and Guenther, 2006; Grbich, 1999). According to Falk and Guenther (2006), generalizability is possible from qualitative research. It is possible partly because of the replicability of the findings across several populations. So if, using the same methods, we can demonstrate the same findings in several (like or even unlike) population groups, then we can correctly assert that the findings are generalizable beyond the initial one or two cases.

After the instrument was developed, we used three case studies to test its application, to determine whether it improved and facilitated the implementation of information systems that met developing country needs. The choice of the case study method was based on the views of several renowned researchers who state that case study research is the most common qualitative research method used in studying information systems research (Myers, 2009; Alavi and Carlson, 1992; Orlikowski and Baroudi, 1991).

We used qualitative research methods because the aim was to obtain feedback on user attitudes and experience in using the IS assessment instrument and the studio-based approach as a whole, in the assessment of information systems. We used questionnaires and informal interviews to gather feedback from the respondents regarding whether the IS assessment instrument facilitated them in the assessment of information systems. The case study enabled us to fulfill the aim of testing the artifact in its stakeholder environment.

The IS success challenges identified during the exploratory study are common to most organizations in developing countries that have similar characteristics. Additionally, decision enhancement requirements that formed the basis for the IS assessment instrument, were based on challenges identified from the case study and were in line with the highlighted literature. During evaluation, it was observed that most organizations in Uganda did not have any IS assessment system in place. This was found to be characteristic of most developing countries. The IS assessment instrument was used to assess is in different organizations which included an academic institution, a banking institution and a utility body.

Although we cannot fully generalize our findings, the successful application of the IS assessment instrument at the three cases and positive feedback results received indicate it has potential of being applicable for assessing IS in different organizations that have implemented IS. We observe that the ISASSI instrument has been tested in Uganda, a developing country, to address IS success issues in developing countries. Other LDCs have almost similar challenges to those that are faced by Uganda (see table 1.1). We also used experts from Uganda to carry out the testing. These factors make the basis to conclude that the instrument can be useful and usable for all IS organizations that have similar contextual characteristics. In case of differences, then the instrument could be adjusted to take these into account.

7.3 Further Research

While carrying out this research, several issues were addressed and a number of new issues arose. Given the time and resource constraints, we were unable to address all of these issues. Therefore, as future research, the following recommendations are made:

Recommendation 1

To further address generalizability issues, the ISASSI may be implemented in other developing countries.

Recommendation 2

Results show that the ISASSI works well in large organizations. Therefore, further research in its applicability in SMEs is recommended.

Recommendation 3

One of the issues that arise during the maintenance period of the information system is the cost of maintenance. It is recommended to incorporate a costing tool for determining whether it is still cost-effective to keep the IS.

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Appendix A-INTERVIEW GUIDE FOR IS EXECUTIVES

A Survey of Information Technology Investments in Uganda.
This is to request you to provide us with your perception on the effect of Quality of Requirements on your Information Systems performance. None of the data and information you provide will be disclosed. All data will be amalgamated with other data and information collected from other respondents.
Title: Surname:Initial:
Department:..
Position:...
Company Name:..
Company Address:...
::
Email:...
Tel No:.
Fax No:.
Personal Profile
Q1. How would you describe your job function? (Please tick one of the following roles that form the core part of your job function):
a) IT Management
b) IT Strategy and Planning
c) Business Services
d) IT Consultancy
e) Systems Management
f) Research and Development
g) Software engineering
h) Others (Please specify):...
Q2. How long have you worked your current organization?
a) Under 1yr. b) 1 - 2yrs
c) 3 - 6yrs d) 6 - 10yrs
e) 10yrs+
Q3. How long have you worked as an IT Manager/decision maker?
a) Under 1yr. b) 1 - 2yrs
c) 3 - 6yrs d) 6 - 10yrs
e) 10yrs+
Q4. What is your current Management level (Please tick one):
a) First line Supervisor or Manager
b) Mid-level manager (supervising other managers)
c) Executive (Top) level Manager (Vice President, Executive Secretary, President, Chairman of the Board of Directors etc)
Information systems should be interpreted broadly, as the systems that support your organization's use of information including PCs, Intranets, databases, software products and communication channels such as mobile phones and PDAs. In your particular case, the Information System should be construed as the application that is directly under your responsibility.
User satisfaction is a reflection of the extent to which a user of your organization's systems is happy with those systems. Users may include your organization's customers as well as staff.
Requirements are the documents developed to justify an investment in information systems. The investment may be in training, hardware, software and/or networks.

Service quality is the quality of the support available to users of your organization's information systems. It may include aspects such as reliability, responsiveness and empathy as well as technical competence.
System quality is the quality of your organization's information systems from the technical perspective. It is usually related to the utilization of your system by users.
Net Benefits capture the balance of the positive and negative impacts of your information system on your customers, suppliers, employees and your organization. Some of the benefits could be improved access to information, quality of work, improved access to information for decision making, increased productivity, incremental sales or ease of carrying out specific tasks using the information system.
System use is the individuals' behavior or effort put into using your organization's IS. It could be visiting a website and searching for information, information retrieval or execution of a specific transaction. The benefits from system use are related to the extent, nature, quality and appropriateness of the system use.
The following questions seek to ascertain the extent to which quality requirements and Information Systems are perceived in your organization
(Please tick the box that best matches your reaction to the statement in each question)
Organizational Profile
Q5. The quality of the requirements has directly affected the quality of your organization's Information System
Highly Agree Agree Neutral Disagree Highly Disagree
Q6. Quality Requirements result into improved system quality
Highly Agree Agree Neutral Disagree Highly Disagree
Q7. Quality Requirements provide quality information to decision makers within the organization
Highly Agree Agree Neutral Disagree Highly Disagree
Q8. Modifications are being made to your information system over the entire system life cycle
Highly Agree Agree Neutral Disagree Highly Disagree
Q9. Frequent changes in requirements reduce system quality
Highly Agree Agree Neutral Disagree Highly Disagree
Q10. Requirements changes affect the quality of information
Highly Agree Agree Neutral Disagree Highly Disagree
Q11. Top Management Support is very instrumental in deriving quality requirements
Highly Agree Agree Neutral Disagree Highly Disagree
Q12. Top Management Support leads to higher user satisfaction
Highly Agree Agree Neutral Disagree Highly Disagree
Q13. Top Management Support leads to better service quality
Highly Agree Agree Neutral Disagree Highly Disagree
Q14. Information Quality influences the decision making process
Highly Agree Agree Neutral Disagree Highly Disagree
Q15. Information Quality affects user satisfaction
Highly Agree Agree Neutral Disagree Highly Disagree
Q16. Information inadequacy leads to less system use
Highly Agree Agree Neutral Disagree Highly Disagree
Q17. Higher System Quality leads to greater system use
Highly Agree Agree Neutral Disagree Highly Disagree
Q18. Using the information system increases productivity
Highly Agree Agree Neutral Disagree Highly Disagree
Q19. Higher System Quality leads to improved information quality
Highly Agree Agree Neutral Disagree Highly Disagree
Q20. Higher System quality leads to increased user satisfaction
Highly Agree Agree Neutral Disagree Highly Disagree
Q21. The higher the system quality the more the system is used
Highly Agree Agree Neutral Disagree Highly Disagree
Q22. Greater user satisfaction leads to higher IS usage
Highly Agree Agree Neutral Disagree Highly Disagree
Q23. Higher User satisfaction results in better Quality Requirements

Highly Agree Agree Neutral Disagree Highly Disagree
Q24. By your organisation's information system generally meeting the expectations of the users, their satisfaction is increased
Highly Agree Agree Neutral Disagree Highly Disagree
Q25. Well trained and informed IT support personnel are key in productive IS investment
Highly Agree Agree Neutral Disagree Highly Disagree
Q26. Improved Service Quality from the IT support personnel enhances user satisfaction
Highly Agree Agree Neutral Disagree Highly Disagree
Q27. Improved Service Quality from the IT support personnel improves job performance
Highly Agree Agree Neutral Disagree Highly Disagree
Q28. Net benefits of your organisation's information system refer to improved quality
of the work done, and access to better information for decision making.
Highly Agree Agree Neutral Disagree Highly Disagree
Q29. One of the net benefits of IS is that it makes it easier to carry out the work
Highly Agree Agree Neutral Disagree Highly Disagree
Q30. Having greater control over one's work is a net benefit
Highly Agree Agree Neutral Disagree Highly Disagree
Q31. Please rank in order of importance to you by putting a number in the box with the
highest as "1".
Management Support
User satisfaction
Information Quality
Service Quality
System Use
Q32. In your opinion, how important is top management support in defining quality of requirements
Very Important Fairly Important Neutral Important Not Important
Q33. In your opinion, what influences the quality of requirements for your Information System?

Q34. In your opinion, what other factors influence the success of your Information System?

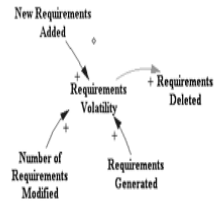
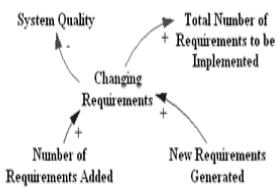
Q35. Which of the Tools below have you used in IS for IS assessment?
(Please tick as many as possible)
Payback Method Accounting Rate of Return Cost Based Ratio
Return On Investments Internal Rate of Return Strategic Cost Management
Discounted Cash Flow Net Present Value
Q36. Basing on your response to questions 34 and 35 above, what is your recommendation for improving IS assessment?

Q37. We would like to conduct a follow-up interview on these important issues, would you be willing to take part?
Yes No (please TICK one)

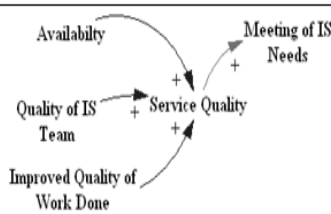
Appendix B-Questionnaire for Consistency Check of Influence Diagram

Questionnaire for consistency check of the Model for Information systems Success
Introduction: These influence diagrams were designed by the PhD student with the following aims- to capture the dynamic cycles of influence that would serve to show where leverage points in an information system exist as well as facilitate the construction of an IS success simulation model which requires extensive detail in the model building.
Objectives of the Questionnaire
-Test for clarity: the extent to which the model clearly captures and communicates issues associated with information systems success.
-Test the existence of the variables that are shown in the diagram.
-Test whether the relationship between variables in the model have been clearly represented.
Target Audience:
Twelve of the IS managers that participated in the field study in Uganda acting as experts in the IS field.

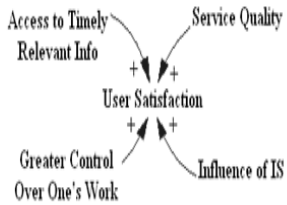
Test for Clarity

NO	Causal Link	Verbal Statement	Questions	Response
1		An increase in the following :- • new requirements added, • number of requirements modified, • and requirements generated, increases the level of requirements volatility. increase in requirements deleted negatively influences the level of requirements volatility.	Do all the variables stated in this diagram exist? Do the relationships between these variables exist? Are there any significant cause factors missing? If so, list them. Are the directions of the links right or they need to be reversed (implying that the effect is the cause). What other effects could be observed as a result of this cause?	
2		An increase in the following :- • number of requirements added, • and new requirements generated, increases the level of changing requirements. Increase in changing requirements negatively influences systems quality, while it positively influences the total number of requirements to be implemented	Do all the variables stated in this diagram exist? Do the relationships between these variables exist? Are there any significant cause factors missing? If so, list them. Are the directions of the links right or they need to be reversed (implying that the effect is the cause). What other effects could be observed as a result of this cause?	

Test for Existence of Variables Shown in the Diagram

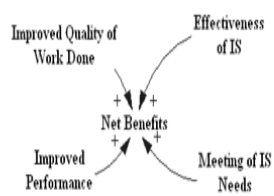
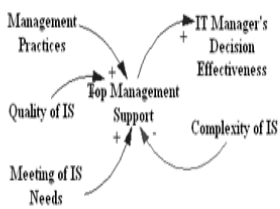
3		An increase in the following :- • availability, • timeliness, • reliabilty, • accuracy, • completeness, • and information relevance, increases the level of information quality. Increase in information quality positively influences the quality of IS.	Do all the variables stated in this diagram exist?	
			Do the relationships between these variables exist?	
			Are there any significant cause factors missing? If so, list them.	
			Are the directions of the links right or they need to be reversed (implying that the effect is the cause).	
			What other effects could be observed as a result of this cause?	
4		An increase in the following :- • system availability, • quality of IS, • improved quality of work, increases the level of service quality. Increase in service quality positively influences meeting of IS needs of users.	Do all the variables stated in this diagram exist?	
			Do the relationships between these variables exist?	
			Are there any significant cause factors missing? If so, list them.	
			Are the directions of the links right or they need to be reversed (implying that the effect is the cause).	
			What other effects could be observed as a result of this cause?	
5		An increase in the following :- • system quality, • technical effectiveness, • effectiveness of IS, • responsiveness of IS team, • service quality, • and willingness to participate, increases the level of systems use.	Do all the variables stated in this diagram exist?	
			Do the relationships between these variables exist?	
			Are there any significant cause factors missing? If so, list them.	
			Are the directions of the links right or they need to be reversed (implying that the effect is the cause).	
			What other effects could be observed as a result of this cause?	

Test for Existence of Variables Shown in the Diagram2

6		An increase in the following :- • timely or relevant information, • greater control over one's work, •influence of IS, • service quality of IS team, increases the level of user satisfaction.	Do all the variables stated in this diagram exist?	
			Do the relationships between these variables exist?	
			Are there any significant cause factors missing? If so, list them.	
			Are the directions of the links right or they need to be reversed (implying that the effect is the cause).	
			What other effects could be observed as a result of this cause?	

Test Whether Relationships are Clearly Represented

.

7		An increase in the following :- • improved quality of work done, • improved performance, •effectiveness of IS, • and meeting of IS needs, increases the level of net benefits.	Do all the variables stated in this diagram exist?	
			Do the relationships between these variables exist?	
			Are there any significant cause factors missing? If so, list them.	
			Are the directions of the links right or they need to be reversed (implying that the effect is the cause).	
			What other effects could be observed as a result of this cause?	
8		An increase in the following :- • better management practices, • quality of IS, •meeting of IS needs, increases the level of top management support. Increase in complexity of IS reduces top management support. Increase in top management support positively influences IT manager's decision effectiveness.	Do all the variables stated in this diagram exist?	
			Do the relationships between these variables exist?	
			Are there any significant cause factors missing? If so, list them.	
			Are the directions of the links right or they need to be reversed (implying that the effect is the cause).	
			What other effects could be observed as a result of this cause?	

Consistency Check of the Influence Diagram
In your opinion, how do you rate this influence diagram?
1. Reasonable (realistic):
[a] Very reasonable
[b] Reasonable
[c] Fairly reasonable
[d] Not reasonable
2. Representation of issues concerning IS success
[a] Very good
[b] Good
[c] Fairly good
[d] Not at all good
3. Communication of issues concerning IS success
[a] Very useful
[b] Useful
[c] Fairly useful
[d] Not at all useful
4. How do you rate the influence diagram as an aid for understanding IS success?
[a] Very useful
[b] Useful
[c] Fairly useful
[d] Not at all useful
Thank you.

Appendix C-Results of Field Studies

Length of Time as IT manager

How Long Have You Worked

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under 1 Year	5	16.1	16.1	16.1
	1-2 Years	2	6.5	6.5	22.6
	3-6 Years	9	29.0	29.0	51.6
	6-10 Years	9	29.0	29.0	80.6
	10Yrs+	6	19.4	19.4	100.0
	Total	31	100.0	100.0	

Figure 7.1: Time in IT Management

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Reliability

Reliability

Warnings

The space saver method is used. That is, the covariance matrix is not calculated or used in the analysis.

Case Processing Summary

		N	%
Cases	Valid	31	100.0
	Excluded[a]	0	.0
	Total	31	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.822	26

Figure 7.2: Cronbach Alpha

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Quality of Requirements

Quality of requrements has directly affected your IS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	1	3.2	3.2	3.2
	Agree	11	35.5	35.5	38.7
	Highly Agree	19	61.3	61.3	100.0
	Total	31	100.0	100.0	

Quality requirements result in improved system quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	10	32.3	32.3	32.3
	Highly Agree	21	67.7	67.7	100.0
	Total	31	100.0	100.0	

Quality requirements provide quality info to decision makers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Neutral	4	12.9	12.9	16.1
	Agree	13	41.9	41.9	58.1
	Highly Agree	13	41.9	41.9	100.0
	Total	31	100.0	100.0	

Requirements Volatility

Modifications are being made to your IS over the system lifecycle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Disagree	2	6.5	6.5	9.7
	Neutral	4	12.9	12.9	22.6
	Agree	18	58.1	58.1	80.6
	Highly Agree	6	19.4	19.4	100.0
	Total	31	100.0	100.0	

Frequent changes in requirements reduce system quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	8	25.8	25.8	25.8
	Neutral	7	22.6	22.6	48.4
	Agree	8	25.8	25.8	74.2
	Highly Agree	8	25.8	25.8	100.0
	Total	31	100.0	100.0	

Requirements changes affect the quality of information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	11	35.5	35.5	35.5
	Neutral	3	9.7	9.7	45.2
	Agree	12	38.7	38.7	83.9
	Highly Agree	5	16.1	16.1	100.0
	Total	31	100.0	100.0	

Top Management Support

Top Management support instrumental in deriving quality requirements

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Disagree	2	6.5	6.5	9.7
	Neutral	5	16.1	16.1	25.8
	Agree	11	35.5	35.5	61.3
	Highly Agree	12	38.7	38.7	100.0
	Total	31	100.0	100.0	

Top Management support leads to higher user satisfaction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Disagree	5	16.1	16.1	19.4
	Neutral	7	22.6	22.6	41.9
	Agree	10	32.3	32.3	74.2
	Highly Agree	8	25.8	25.8	100.0
	Total	31	100.0	100.0	

Top Management support leads to better service quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	4	12.9	12.9	12.9
	Agree	16	51.6	51.6	64.5
	Highly Agree	11	35.5	35.5	100.0
	Total	31	100.0	100.0	

Information Quality

Information Quality influences decison making

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	3	9.7	9.7	9.7
	Agree	15	48.4	48.4	58.1
	Highly Agree	13	41.9	41.9	100.0
	Total	31	100.0	100.0	

Information quality affects user satisfaction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	6.5	6.5	6.5
	Neutral	4	12.9	12.9	19.4
	Agree	13	41.9	41.9	61.3
	Highly Agree	12	38.7	38.7	100.0
	Total	31	100.0	100.0	

Information inadequacy leads to less system use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	2	6.5	6.5	6.5
	Disagree	2	6.5	6.5	12.9
	Neutral	4	12.9	12.9	25.8
	Agree	15	48.4	48.4	74.2
	Highly Agree	8	25.8	25.8	100.0
	Total	31	100.0	100.0	

System Quality

Higher system quality leads to improved information quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Disagree	3	9.7	9.7	12.9
	Neutral	8	25.8	25.8	38.7
	Agree	9	29.0	29.0	67.7
	Highly Agree	10	32.3	32.3	100.0
	Total	31	100.0	100.0	

Higher system quality leads to increased user satisfaction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	9.7	9.7	9.7
	Neutral	7	22.6	22.6	32.3
	Agree	11	35.5	35.5	67.7
	Highly Agree	10	32.3	32.3	100.0
	Total	31	100.0	100.0	

The higher the system quality the more the system is used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Disagree	2	6.5	6.5	9.7
	Neutral	10	32.3	32.3	41.9
	Agree	11	35.5	35.5	77.4
	Highly Agree	7	22.6	22.6	100.0
	Total	31	100.0	100.0	

User Satisfaction

Greater user satisfaction leads to higher IS usage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	3.2	3.2	3.2
	Neutral	5	16.1	16.1	19.4
	Agree	12	38.7	38.7	58.1
	Highly Agree	13	41.9	41.9	100.0
	Total	31	100.0	100.0	

Higher user satisfaction results in better quality requirements

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	16.1	16.1	16.1
	Neutral	9	29.0	29.0	45.2
	Agree	13	41.9	41.9	87.1
	Highly Agree	4	12.9	12.9	100.0
	Total	31	100.0	100.0	

By your IS meeting expectations of users satisfaction is increased

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	2	6.5	6.5	6.5
	Agree	17	54.8	54.8	61.3
	Highly Agree	12	38.7	38.7	100.0
	Total	31	100.0	100.0	

Service Quality

well trained and informed IT personnel are key in productive IS investment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	2	6.5	6.5	6.5
	Disagree	1	3.2	3.2	9.7
	Neutral	3	9.7	9.7	19.4
	Agree	6	19.4	19.4	38.7
	Highly Agree	19	61.3	61.3	100.0
	Total	31	100.0	100.0	

Improved service quality from the IT support personnel enhances user satisfaction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Disagree	1	3.2	3.2	6.5
	Agree	13	41.9	41.9	48.4
	Highly Agree	16	51.6	51.6	100.0
	Total	31	100.0	100.0	

Improved service quality from the IT support personnel improves job performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	3.2	3.2	3.2
	Neutral	3	9.7	9.7	12.9
	Agree	15	48.4	48.4	61.3
	Highly Agree	12	38.7	38.7	100.0
	Total	31	100.0	100.0	

Net Benefits

Net Benefits of IS refer to improved quality of work done and access to better information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	5	16.1	16.1	16.1
	Agree	17	54.8	54.8	71.0
	Highly Agree	9	29.0	29.0	100.0
	Total	31	100.0	100.0	

One of the net benefits of IS is that it makes it easier to carry out the work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	2	6.5	6.5	6.5
	Agree	19	61.3	61.3	67.7
	Highly Agree	10	32.3	32.3	100.0
	Total	31	100.0	100.0	

Having greater control over one's work is a net benefit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	1	3.2	3.2	3.2
	Disagree	2	6.5	6.5	9.7
	Neutral	8	25.8	25.8	35.5
	Agree	13	41.9	41.9	77.4
	Highly Agree	7	22.6	22.6	100.0
	Total	31	100.0	100.0	

Systems Use

Frequency Table

Using the information system increases productivity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	4	12.9	12.9	12.9
	Agree	19	61.3	61.3	74.2
	Highly Agree	8	25.8	25.8	100.0
	Total	31	100.0	100.0	

Information inadequacy leads to less system use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly Disagree	2	6.5	6.5	6.5
	Disagree	2	6.5	6.5	12.9
	Neutral	4	12.9	12.9	25.8
	Agree	15	48.4	48.4	74.2
	Highly Agree	8	25.8	25.8	100.0
	Total	31	100.0	100.0	

MIS Presence

Please indicate if you have a specialised Management Information Systems Department

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	25	80.6	80.6	80.6
	No	6	19.4	19.4	100.0
	Total	31	100.0	100.0	

Appendix D-Interview Guide for Identifying Input Variables for the IS Success Instrument

INTERVIEW GUIDE FOR IDENTIFYING INPUT VARIABLES FOR THE IS SUCCESS INSTRUMENT

Objectives of the Interview

Identify the input variables for the instrument.

Identify the most important input variables.

Carry out a sensitivity analysis with the managers for face validity of the instrument.

Target Audience

Ten of the IS managers that participated in the field study in Uganda acting as experts in the IS field from URA.

Identifying the input variables

1. In your opinion, which are the input variables that should be made available to a user of the instrument to be able to use the instrument to assess IS success?

2. In your opinion, which are the 2 most important input variables?

Sensitivity Analysis

1. In your opinion, does the behavior of the instrument mimic what your expectations of what would happen with, say the Etax system?

2. Are you in agreement that requirements volatility and other variables as portrayed in the sensitivity analysis is a true representation of the real system?

3. In your opinion, can the instrument be used to assess information system success in its current form?

Thank you.

Appendix E-Questionnaire for Testing the Instrument with IS Practitioners

A Questionnaire for Testing an Instrument for Assessing of Information Systems (IS) Success

Introduction:

The variables in the instrument for assessing of IS success are explained by the PhD student and the questions posed are supposed to help improve it.

Preamble:

Information systems (IS) success is a field that is attracting a lot of attention lately. Many reasons, models and techniques have been advanced to improve success, but success still eludes organizations.

An instrument for predicting IS success should provide decision makers with information about the degree to which the IS is fulfilling organizational objectives. To get this information, an appropriate set of success variables is required. To this end the instrument presented can help decision makers gain insights of systems behavior over time, which may reveal what aspects of IS to review and update. The decision maker is usually confronted with a large and complex amount of information, usually of a conflicting nature and reflecting multiple interests. The managers working collectively can get feedback from the users, by using questionnaires; and the results fed into the instrument. Using user satisfaction and information quality as proxies for IS success; the use of such an instrument can be very valuable in assisting decision makers organize such information in order to identify a preferred course of action.

Explanation of Variables in the Instrument

User satisfaction is a reflection of the extent to which a user of your organization's systems is happy with those systems. Users may include your organisations customers as well as staff.

Requirements are the descriptions of what software should do and are also used to justify an investment in information systems. The investment may be in training, hardware, software and/or networks.

Service quality is the quality of the support available to users of your organizations information systems. It may include aspects such as reliability, responsiveness and empathy as well as technical competence.

System quality is the quality of your organizations information systems. It is related to the utilization of your system by users.

Net Benefits capture the balance of the positive and negative impacts of your information system on your customers, suppliers, employees and your organization. Some of the benefits could be improved access to information for decision making, quality of work, increased productivity, incremental sales or ease of carrying out specific tasks using the information system.

System use is the individuals behavior or effort put into using your organizations information systems. It could be visiting a Web site and searching for information, information retrieval or execution of a specific transaction. The benefits from system use are related to the extent, nature, quality and appropriateness of the system use.

Top management support for information systems refers to the senior executives' favorable attitude toward, and explicit support for information systems. Facilitating conditions for information systems reflect the processes and resources that facilitate an individuals ability to utilize information systems. When top management is highly supportive of information systems, greater resources are likely to be allocated to develop and support information systems.

Usefulness

1. Having interacted with the instrument, how useful is this instrument in measuring IS success?

Very useful

Fairly useful

Could be improved

Not at all useful

2. In your opinion are the variables as explained above able to help in prediction of IS success?

Yes

No

3. If your answer in 2 above is NO, please give reasons.

4. In your opinion, does the Instrument capture all the factors associated with IS success?

Yes

No

5. If your answer to 4 above is NO, please suggest any factors that you consider should be included.

Testing Actual Use/Overall Assessment of the Instrument for IS Success

1. In your opinion, how do you rate this Instrument?

Very useful

Useful

Fairly useful

Not useful

2. Representation of the issues in the Instrument

Very good

Good

Fairly good

Not at all good

3. Communication tool concerning information systems success issues

Very useful

Useful

Fairly useful

Not at all useful

4. Aid to IS managers for IS success prediction

Very useful

Useful

Fairly useful

Not at all useful

Usability Testing

Usability is the degree to which a given product or system assists the person using it to accomplish a task. Having interacted with the interface for the instrument, please answer the following questions.

1. Do you find the interface easy to navigate?

No problems

Could be improved

2. If you think it could be improved, how might it be improved?

Better navigation

Reorganized

Other- Specify

3. What do you like most about the interface?

Color

Content

Understandability

4. Is the interface meaningful to you?

Yes

No

5. Is the interface easy for a user to understand

Yes

No

6. In your opinion, does the interface prevent the user from making common errors like deleting some of the icons/keys?

Yes

No

7. Does the arrangement where only buttons and sliders are used on the interface in your opinion reduce information load?

Yes

No

8. Does the facility of Undo and Redo increase the confidence of users in interacting with the interface?

Yes

No

Potential Usage Testing

Usage expresses the flexibility, adaptavity and suitability of the instrument to meet the organizational, technical and social context. 1. In your view, can the instrument be accepted in your IS assessment process?

2. The guidelines were very clear to me

[1] Seriously Disagree

[2] Disagree

[3] Not Sure

[4] Agree

[5] Strongly Agree

3. Using the Instrument helped me a get a better understanding of IS success.

[1] Seriously Disagree

[2] Disagree

[3] Not Sure

[4] Agree

[5] Strongly Agree

4. I used the instrument with my others in my department to solve IS issues.

[1] Seriously Disagree

[2] Disagree

[3] Not Sure

[4] Agree

[5] Strongly Agree

5. I used the instrument with others to interpret IS issues

[1] Seriously Disagree

[2] Disagree

[3] Not Sure

[4] Agree

[5] Strongly Agree

6. I experienced many technical problems while using the instrument

[1] Seriously Disagree

[2] Disagree

[3] Not Sure

[4] Agree

[5] Strongly Agree

7. I was comfortable working with the instrument

[1] Seriously Disagree

[2] Disagree

[3] Not Sure

[4] Agree

[5] Strongly Agree

8. How frequently did you use the instrument

[1] Very Rarely

[2] Rarely (a few times per week)

[3] Occasionally (twice per week)

[4] Regularly (several times per week)

[5] Strongly Agree (several times per day)

Thank you.

Appendix F-Model Formulation and Equations for The Instrument

SD Model Building Blocks

The back-end of the instrument was developed with STELLA software Research Version 8.1.1. STELLA (Ithink® 2007) is a computer simulation program which provides a modeling environment for dynamic systems. STELLA provides a friendly graphical interface and environment for observing quantitative interaction of variables within a system. STELLA software uses the four basic elements explained below:- Stock (Level) is a generic symbol for anything that accumulates or drains. Stocks can be physical in nature such as population, water and cash or non-physical such as motivation, user satisfaction and trust. Survival of systems is critically dependent on stocks and as such they play an important role in dynamic feedback management problems.

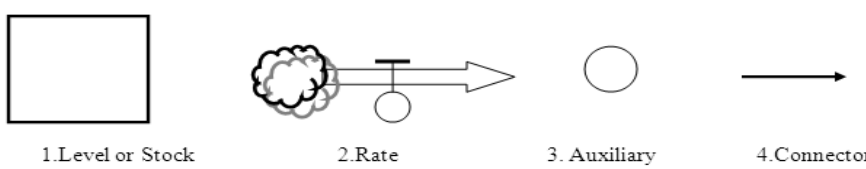


Figure 7.3: Four Basic Symbols Used in System Dynamics Modeling [Adapted from Williams, 2002]

Flow is the rate of change of a stock. Flows update the magnitude of stocks and exist over a period of time. According to Maani and Cavana (2003), flows are usually outcomes of decisions by management or external forces outside management control. They can only be observed by accumulation or averaging and not by a single point in time. Flows can

be physical or non physical in nature just like stocks. The flow provides the dynamics of the system.

Converter or auxiliary variable is used to take input data and manipulate or convert that input into some output signal. Converters include constants, graphical relationships and behavioral relationships. They are commonly used to define derived variables as well as construct relationships that can be substituted into flow equations. They are used to break up complex flow equations into simpler components. Converters may be used for doing algebraic operations (sums or division), representing exogenous inputs (ramps, steps, and randomness), and serving as substitutes for either stocks or flows that may not be represented for simplification.

Connector also known as linker is an arrow that allows information to pass between converters and converters, stocks and converters, stocks and flows, and converters and flows. They serve as inputs and outputs and not inflows and outflows. There are two types of connectors namely :-the action connector represented by a solid wire which converts the resulting decision into an action that ultimately changes the volume flow and the information connector dashed wire which provides information that is used to arrive at a decision. STELLA uses equations that are in-built in the four basic elements mentioned above, to convert the influence diagrams into differential equations, of the type like the one illustrated below:

$$S(t) = S(t - dt) + (I - O)dt \tag{7.1}$$

$$INITS = 100units \tag{7.2}$$

Equation (5.1) represents stock at present time (t) which is equal to the stock at previous time S (t-dt) plus inflows (I) less the outflows (O) during the period (dt). The second equation gives the initial value of the stock.

Flow Equation is generally a policy statement in the system reflecting the rate at which the system will change during forthcoming simulation interval of time (i.e. the next DT). For example :

$$\frac{Change\_in\_satisfaction = User\_satisfaction * Perceived\_effectiveness}{Technical\_effectiveness\_adjustment\_time} \tag{7.3}$$

This implies that the user satisfaction of the specified interval is equal to the user satisfaction multiplied by the user satisfaction rate. Converter Equation is an intermediate

variable, constant or graphical relationship such as:

$$Perceivedeffectiveness \tag{7.4}$$

The back-end was made of the following equation formulations :

Linear equations-which assume that the output is proportional to the input with this general form equation :-

$$Y = a + bX \tag{7.5}$$

where the intercept a and slope b are both constants.

Non-linear equations -which arise from the dynamic feedback nature of the model where the output is a function of the product of a number of variables. An example of such an equation is:

$$Y = a + bX + cdY^2 \tag{7.6}$$

State (Endogenous) variables for the Requirements Sub-model

The total documents reviewed represented by the sub-model is formulated by the following equation:

$$Docs\_reviewed(t) = docs\_reviewed(t-dt)+(Review\_rate-change\_in\_req\_doc)*dt \tag{7.7}$$

The inflow to this stock is the review rate represented as:

$$Review\_rate = \frac{(Req\_V\&V)}{Mean\_time\_to\_review} \tag{7.8}$$

The outflow from this stock is change in requirements document expressed as:

$$Change\_in\_req\_document = \frac{Documents\_reviewed}{Mean\_time\_to\_review} \tag{7.9}$$

The request que as a result of reviews and also new requirements capture and analysis is formulated by the following equation:

$$Request\_Que(t) = Request\_Que(t - dt) + (Process\_start - Elicitation) * dt \tag{7.10}$$

The initial request que is initialized at 10 pages.

The inflow to this stock is process start and is expressed as:

$$Process\_start = \frac{Normal\_req\_doc}{Initial\_preparation\_time} \tag{7.11}$$

The outflow from this stock is To-Elicitation expresed as:

$$To\_elicitation = \frac{Request\_Que}{Initial\_preparation\_time} \tag{7.12}$$

The requirements verification and validation which is the checking of correctness and completeness of the specification associated with each requirement defined and modeled is formulated by the following equation:

$$Req\_V\&V(t) = Req\_V\&V(t - dt) + (To\_V\&V - Review\_rate) * dt \tag{7.13}$$

The inflow to this stock is given as To verification and validation expressed as:

$$To\_V\&V = \frac{Req\_document}{Mean\_time\_to\_review} \tag{7.14}$$

The outflow from this stock is the review rate expressed as:

$$Review\_rate = \frac{Req\_V\&V}{Mean\_time\_to\_review} \tag{7.15}$$

Time pressure is the negative effect of time pressure on requirements engineers leading to errors. It is represented by the following equation:

$$Time\_Pressure(t) = Time\_Pressure(t - dt) + (Change\_in\_time\_pressure) * dt \tag{7.16}$$

Time pressure is initialized at 0.5 months as the time needed for the first outputs of the elicitation process.
The inflow to this stock is given as:

$$Change\_in\_time\_pressure = Time\_pressure * 0.5 \tag{7.17}$$

Total Number of Error Rework is the accumulated requirements pages rejected as a result of the review process. This stock is represented by the following equation:

$$Total\_error\_reworked(t) = Total\_error\_reworked(t - dt) + (Rework\_rate) * dt \tag{7.18}$$

The inflow to this stock is the rework rate represented by the equation:

$$Rework\_rate = \frac{(Documents\_reviewed * Normal\_acceptance\_fraction)}{Mean\_time\_to\_review} \tag{7.19}$$

The total number of requirements to be implemented per month is expressed by the equation:

$$Tot\_of\_req\_tobe\_impl(t) = Tot\_of\_req\_to\_be\_impl(t - dt) + \frac{Rteof\_chng\_req}{Chng\_in\_time\_pres} * dt \tag{7.20}$$

The inflow to this stock is the rate of change in requirements expressed as:

$$Tot\_no\_of\_Req\_to\_be\_impl = \frac{Tot\_no\_of\_Req\_to\_be\_impl * Top\_mgtsupport}{Chng\_in\_time\_pres * Info\_Qual} \tag{7.21}$$

The outflow from this stock is given by the equation:

$$Chng\_in\_time\_pres = 0.5 * Time\_pressure \tag{7.22}$$

Elicitation and Definition is a special stock type that represents the gathering of requirements through a range of techniques with each requirement elicited defined. Approximately on average there about 20 requirements per page. Number of pages is a better measure used to represent size. Elicitation of requirements and defining them is the initial activity in the requirements engineering process. This process can take in as many requirements from different sources. It is expressed by the equation:

$$Elicitation(t) = Elicitation(t - dt) + (To\_Elicitation - To\_Modeling) * dt \tag{7.23}$$

The inflow to this stock is given by the equation:

$$To\_Elicitation = \frac{Request\_Que}{Initial\_preparation\_time} \tag{7.24}$$

The outflow from this stock, Transit time for elicitation, is given by the equation:

$$Transit\_Time = \frac{Elicitation * Initial\_preparation\_time}{Fraction\_Elicitation\&Definition} \tag{7.25}$$

Requirements Management is a special type of Level representing the maintenance of specification of requirements into functional and non-functional requirements in the requirements database. On average there about 20 requirements per page in a requirements document. Therefore the number of pages in the requirements documents multiplied by 20 provide us with the size of the database. Number of requirements in the database is a better measure used to represent size in requirements engineering projects (Williams and Kennedy, 2000). It is expressed by the equation:

$$Requirements\_Mngt(t) = Req\_Mngt(t - dt) + (Spec\_Rate - Transit\_Time) * dt \tag{7.26}$$

The inflow to this stock is Transit time for requirements management, represented by the equation:

$$Transit\_Time = \frac{Req\_Modeling}{Frac\_Modeling} \tag{7.27}$$

The outflow from this stock is given by the equation:

$$Transit\_Time = \frac{Req\_Mgt}{Frac\_Modeling} \tag{7.28}$$

Requirements Modelling is an important activity within the requirements engineering process. Requirements models are used to discover and clarify the functional and data

requirements for software and business systems. Additionally, the requirements models are used as specifications for the designers and builders of the system. Requirements modeling activity is expressed by the equation:

$$Req\_Modeling(t) = Req\_Modeling(t - dt) + (To\_Modeling - Spec\_Rate) * dt \quad (7.29)$$

The inflow to this stock is Transit time for requirements modeling, given by the equation:

$$Transit\_Time = \frac{Elicitation * Initial\_preparation\_time}{Frac\_Elic\_and\_defn} \quad (7.30)$$

The outflow from this stock is given by the equation:

$$Transit\_Time = \frac{Req\_modeling}{Frac\_Modeling} \quad (7.31)$$

State (Endogenous) variables for the Service Quality Sub-model

The level of staff is given by the equation:

$$Level\_of\_staff(t) = Level\_of\_staff(t - dt) + (Staff\_recruitment - Staff\_leaving) * dt \quad (7.32)$$

The inflow to this stock, staff recruitment is given by the equation:

$$Staff\_recruitment = \frac{Staff\_for\_recruitment * Delay\_time}{Unit\_time * Service\_quality} \quad (7.33)$$

The outflow from this stock is given by the equation:

$$Staff\_leaving = Level\_of\_staff * Staff\_leaving\_rate \quad (7.34)$$

Service quality is given by the equation:

$$Service\_quality(t) = Service\_quality(t - dt) + (Change\_in\_service\_quality) * dt \quad (7.35)$$

The inflow to this stock, change in service quality is given by the equation:

$$Chng\_in\_svc\_qual$$

$$= Actual\_svc\_qual * Rem * Imp\_qual\_of\_work\_done * Mting\_of\_IS\_needs * Req\_vol \quad (7.36)$$

State (Endogenous) variables for the Systems Use Sub-model

Actual use is given by the equation:

$$Actual\_use(t) = Actual\_use(t - dt) + (Change\_in\_actual\_use) * dt \quad (7.37)$$

The inflow to this stock, change in actual quality is given by the equation:

$$Change\_in\_actual\_quality = \frac{System\_quality}{Tech\_eff\_adjst\_time} \quad (7.38)$$

Systems use is given by the equation:

$$Systems\_use(t) = Systems\_use(t - dt) + (Change\_in\_systems\_use) * dt \quad (7.39)$$

The inflow to this stock, change in systems use is given by the equation:

$$Change\_in\_sys\_use = (\frac{Svc\_qual + Sys\_qual) * Eff\_of\_IS * Tech\_eff * Willingness\_to\_use\_IS}{Top\_mgt\_support} \quad (7.40)$$

System quality is given by the equation:

$$System\_quality(t) = System\_quality(t - dt) + (Change\_in\_system\_quality) * dt \quad (7.41)$$

The inflow to this stock, change in system quality is given by the equation:

$$Change\_in\_sys\_quality = \frac{Actual\_sys\_quality}{Total\_no\_of\_req\_to\_be\_impl * Tech\_eff\_adjst\_time} \quad (7.42)$$

State (Endogenous) variables for the Top Management Sub-model

Top Management Support is given by the equation:

$$Top\_mgt\_support(t) = Top\_mgt\_support(t - dt) + (Change\_in\_top\_mgt\_support) * dt \quad (7.43)$$

The inflow to this stock, change in top management support is given by the equation:

$$Change\_in\_top\_mgt\_support = IT\_mngrs\_dec\_eff * Meeting\_of\_IS\_needs$$

$$*Svc\_qual * Willingness\_to\_use\_IS * Quality\_of\_IS \quad (7.44)$$

State (Endogenous) variables for the User Satisfaction Sub-model

Perceived performance is given by the equation:

$$Perceived\_performance(t) = Perceived\_performance\_support(t - dt)$$

$$+(Change\_in\_performance - Change\_in\_pressure) * dt \tag{7.45}$$

The inflow to this stock, change in performance is given by the equation:

$$Change\_in\_performance = Improved\_qual\_of\_work\_done * Willingness\_to\_use\_IS \tag{7.46}$$

The outflow to this stock, change in pressure is given by the equation:

$$Change\_in\_pressure = Actual\_performance * Pressure\_to\_improve \tag{7.47}$$

User satisfaction is given by the equation:

$$User\_satisfaction(t) = User\_satisfaction(t - dt) + (Change\_in\_user\_satisfaction) * dt \tag{7.48}$$

The inflow to this stock, change in satisfaction is given by the equation:

$$Change\_in\_satisfaction = Pressure\_to\_improve * Sys\_qual * Top\_mgt\_support$$
$$*Access\_to\_timely\_relevant\_info * Change\_ind$$
$$*Greater\_control\_over\_ones\_work * Improved\_performance * Influence\_of\_IS$$
$$\overline{Req\_Volatility} \tag{7.49}$$

State (Endogenous) variables for the Information Quality Sub-model

Availability is given by the equation:

$$Availability(t) = Availabilty(t - dt) + (Change\_in\_availability) * dt \tag{7.50}$$

The inflow to this stock, change in availability is given by the equation:

$$Change\_in\_availability = Quality\_of\_IS * Reliability * Timeliness \tag{7.51}$$

Information quality is given by the equation:

$$Information\_quality(t) = Information\_quality(t - dt) + (Change\_in\_Information\_quality) * dt \tag{7.52}$$

State (Endogenous) variables for the Net Benefits Sub-model

Net benefits is given by the equation:

$$\text{Net benefits}(t) = \text{Net benefits}(t - dt) + (\text{Change in net benefits}) * dt \tag{7.53}$$

The inflow to this stock, change in net benefits is given by the equation:

$$\text{Chg\_bens} = \text{Effect\_of IS} * \text{Imp\_qual\_work} * \text{Meet\_IS\_needs} * \text{Will\_to use IS} * \text{Top\_mgt supp} * \text{Imp\_pf} \tag{7.54}$$

Appendix G-Open-ended Questions for Case Study

Question: In your opinion, what other factors influence the success of your information system?

Answers:

-Lack of knowledge how to assess IS.

-Lack of knowledge of IS assessment methods.

-Difficulty in using IS assessment methods.

-IS assessment methods are known but they are never used.

-Lack of team work.

-Sidelining of IS staff when making decisions over IS.

-Management not availing enough funds.

-Low morale within the IS staff.

-Lack of top management support.

-Internal politics.

-Rigid organizational culture.

Question: Which of the tools below have you used for IS assessment?

Question: Basing on your response to the questions above, what is your recommendation for improving the assessment of IS?

Answers:

-Most methods are rarely used and users have a deficient background in finance and accounting, methods that take into account all the measures in the IS should be developed.

-Most of the methods use unrealistic assumptions, there should be a sound basis for IS assessment.

-Most of the methods are very complicated, an easy to use method would improve the situation.

-Given that we have many stakeholders with different backgrounds, a support environment to help decision makers is desirable to help improve IS assessment.

-To make more informed decisions, stakeholders must learn more about IS assessment and the methods used in assessing IS.

Appendix H-Behavior Over Time Graph

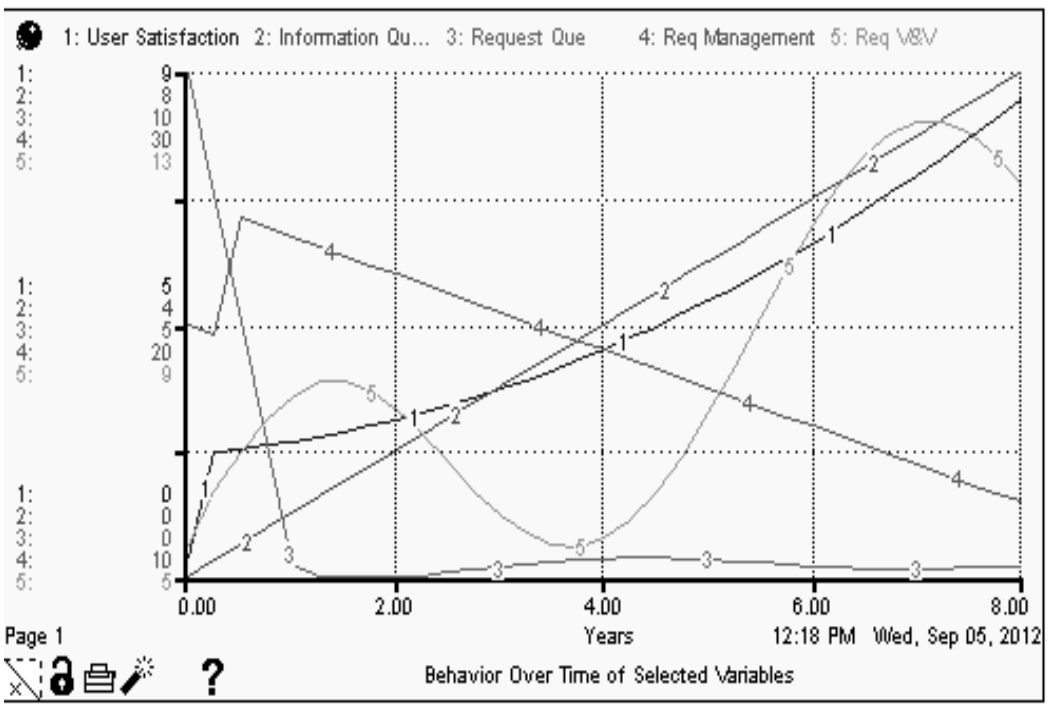
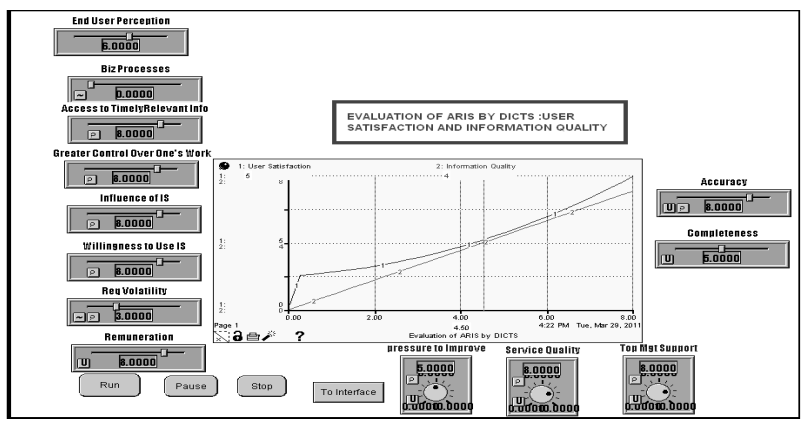


Figure 7.4: Behavior Over Time Graph for 5 Variables

Appendix I-Simulation Results

The details from the simulation experiments for the testing sessions described in chapter 6 are presented below:

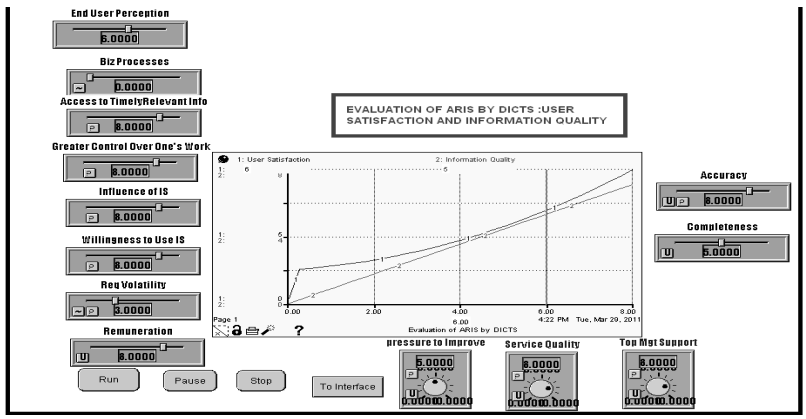
The X-axis represents the number of years that are simulated.
From the simulation run after incorporating these values in the instrument (see table 6.2), using user satisfaction, we observe a sustained increase in user satisfaction at 4.5 years. On the other hand, using information quality, we notice the increase after year 6.



. Figure 7.5: Simulation Result of DICTS Assessment of ARIS for User Satisfaction

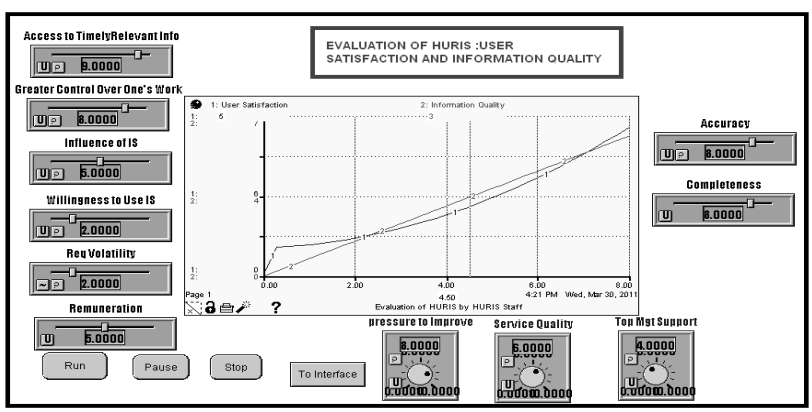
It can readily be seen that there is a slight difference in the simulation results between DICTS evaluation of ARIS and that done by the staff of ARIS, with DICTS success occurring much later at year 6 for information quality as compared to ARIS staff where it occurs at 4.5 years. From the values set by DICTS, it is apparent that DICTS took a pessimistic view of requirements volatility and down graded it to 3 as compared to 2.5 for ARIS staff. This affects the output as we have seen that the model is very sensitive to changes in requirements volatility. On the other hand, ARIS staff were a bit conservative in their estimates of requirements volatility. This could be because the two are operating in separate environments, whereby, the ARIS staff are working on the system daily, while

DICTS provide an overseer role.



. Figure 7.6: Simulation Result of DICTS Assessment of ARIS for Information Quality

From the simulation run after incorporating these values in the instrument (see table 6.3), we observe a sustained increase in user satisfaction at year 4.5 On the other hand, using information quality, we notice success after year 6.



. Figure 7.7: Simulation Result of HURIS Assessment Illustrating User Satisfaction

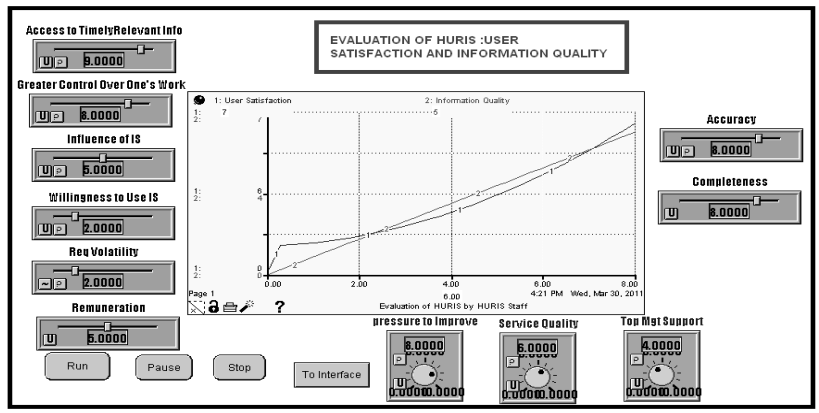


Figure 7.8: Simulation Result of HURIS Assessment Illustrating Information Quality

From the simulation run after incorporating these values in the instrument (see table 6.4), we observe success using increase in user satisfaction at year 4.25. On the other hand, using information quality, we notice the success after 4.75 years.

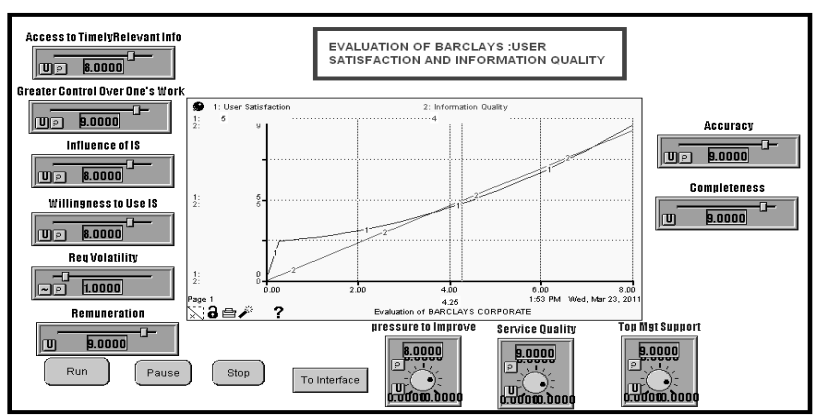


Figure 7.9: Simulation Result of Barclays Corporate Assessment for User Satisfaction

From the simulation run after incorporating these values in the instrument (see table 6.5), we observe a sustained success using user satisfaction at year 3.75 On the other hand, using information quality, we notice the success after year 4.5.

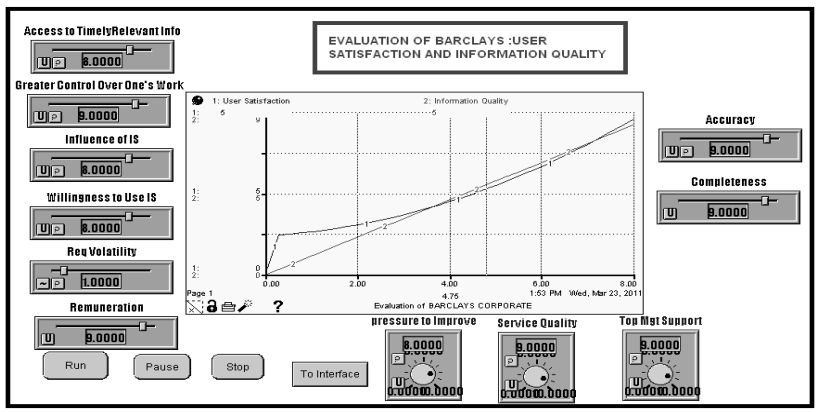


Figure 7.10: Simulation Result of Barclays Corporate Assessment for Information Quality

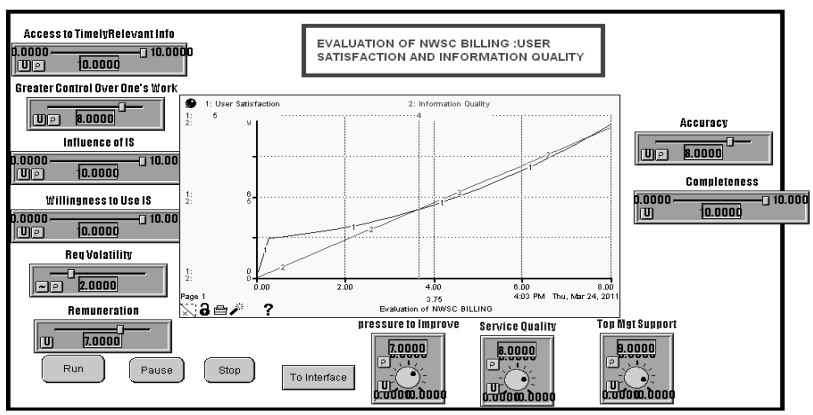


Figure 7.11: Simulation Result of NWSC Billing Assessment Illustrating User Satisfaction

From the simulation run after incorporating these values in the instrument (see table 6.6), we observe success using user satisfaction at year 2.5. On the other hand, using information quality, we notice the success after year 4.5.

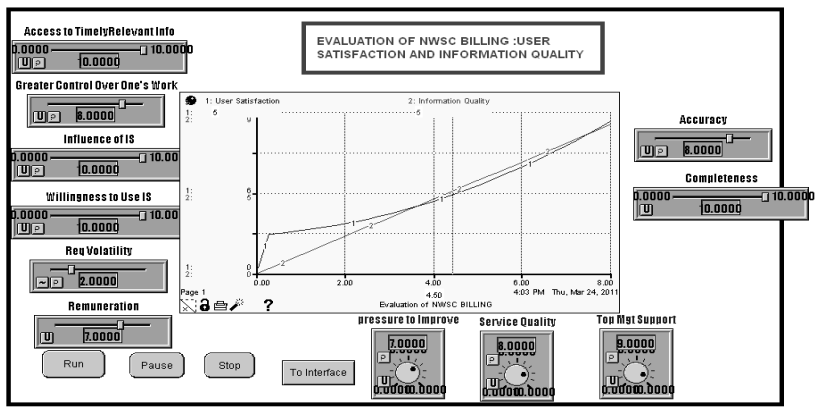


Figure 7.12: Simulation Result of NWSC Billing Assessment Illustrating Information Quality

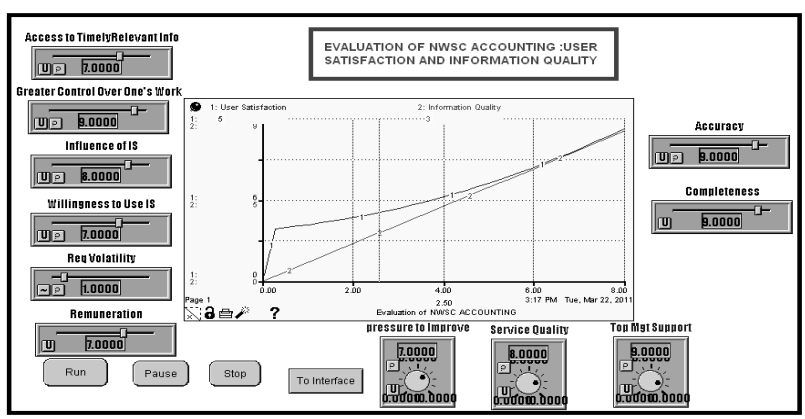


Figure 7.13: Simulation Result of NWSC Accounting Assessment Illustrating User Satisfaction

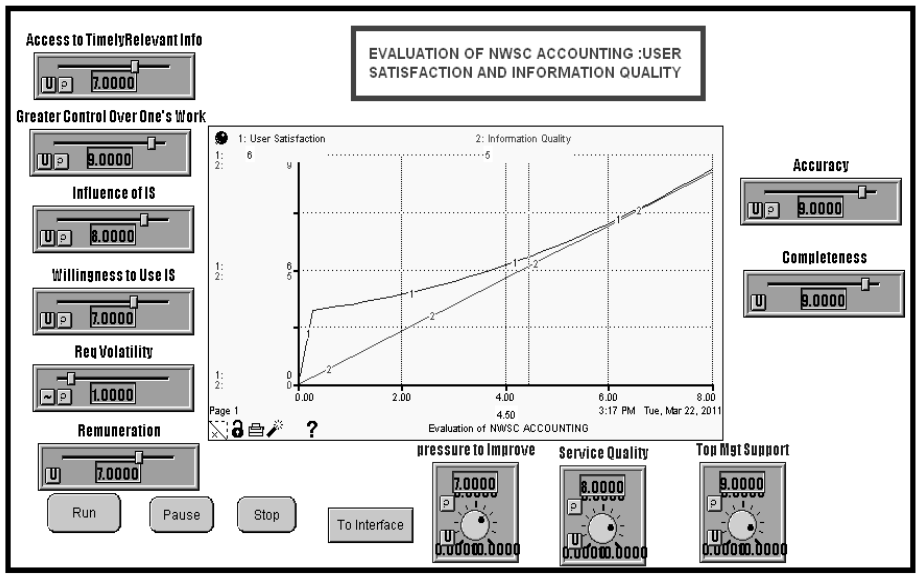


Figure 7.14: Simulation Result of NWSC Accounting Assessment Illustrating Information Quality

From the simulation run after incorporating these values in the instrument (see table 6.7), we observe a sustained increase in user satisfaction at year 2.75. On the other hand, using information quality, we notice the increase after year 4.5.

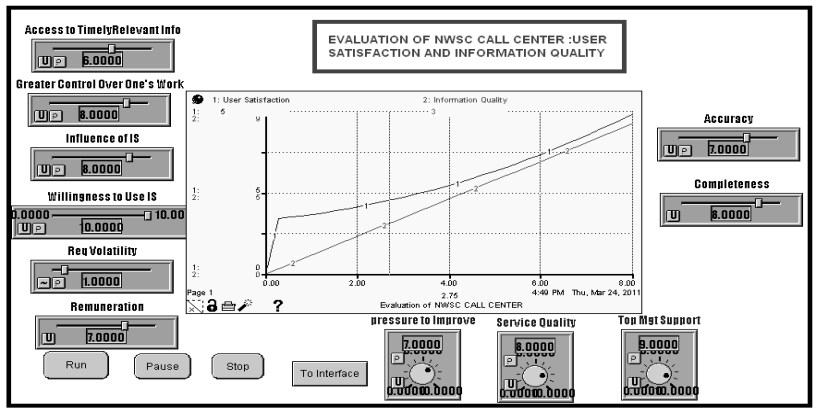


Figure 7.15: Simulation Result of NWSC CALLING CENTER Assessment Illustrating User Satisfaction

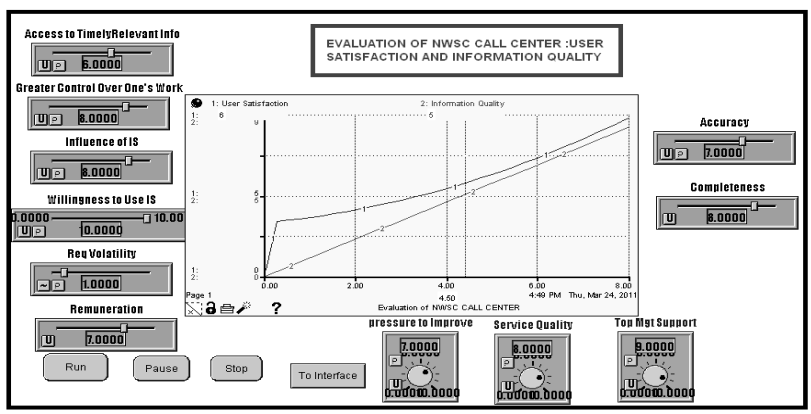


Figure 7.16: Simulation Result of NWSC CALLING CENTER Assessment Illustrating Information Quality

From the simulation run after incorporating these values in the instrument (see table 6.8), we observe success using user satisfaction at year 3.75. On the other hand, using information quality, we notice the success after year 4.5.

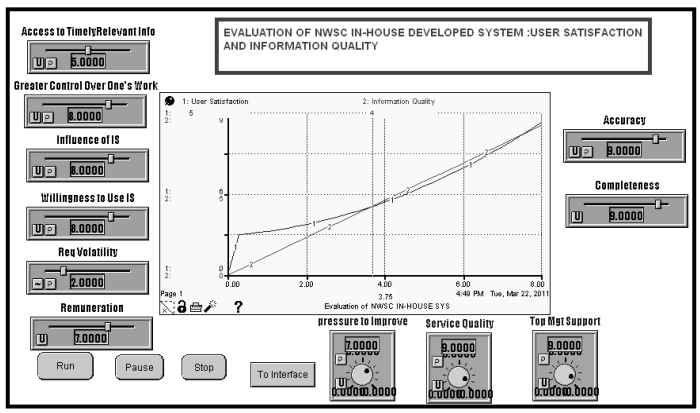


Figure 7.17: Simulation Result of NWSC In-House Developed System Evaluation Illustrating User Satisfaction

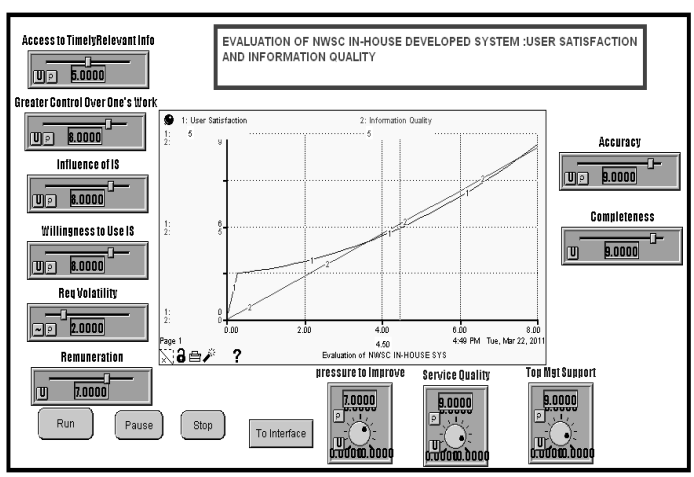


Figure 7.18: Simulation Result of NWSC In-House Developed System Evaluation Illustrating Information Quality

LIST OF ACRONYMS

ARIS	Academic Records Information System
BOU	Bank of Uganda
CIO	Chief Information Officer
DC	Developing Country
DE	Decision Enhancement
DES	Decision Enhancement Studio/Services
DICTS	Directorate for ICT Support
DS	Decision Support
DS	Design Science
FINIS	Financial Information System
GNI	Gross National Income
HURIS	Human Resources Information System
ICT	Information and Communications Technology
IS	Information System
ISASSI	IS Assessment Instrument
IT	Information Technology
ITU	International Telecommunications Union
LDC	Least Developed Country
LIBIS	Library Information System
MUBS	Makerere University Business School
SBU	Stanbic Bank Uganda

Summary

Introduction

From recent research, about 20 to 30 percent of information systems are considered to be outright failures. The situation is worse for developing countries where lack of knowledgeable personnel is also high. The failures in developing countries are due to a number of factors, such as lack of top management support, highly changing requirements, poor infrastructure, political instability, high employee turnover, lack of enough resources to maintain IS. Successful information system implementation is very important for developing countries as poor implementation of IS will have a negative economic impact. Most of the available solutions that are imported from the developed countries are not readily applicable to the developing countries as the contexts in which IS operate are different. Such solutions need considerable adaptation and tailoring to the particular contextual needs in developing countries.

Evidence from literature suggests that ICT is capable of providing solutions to some of the problems faced in developing countries, and that using ICT could improve the implementation of IS in developing countries. There are valid reasons for presenting this argument given that the context of developing countries is characterized mainly by adoption of technologies that are often unsuitable, and costly to implement and maintain within the social, economic, political, and cultural context of developing countries. Developing countries are debt riddled, and in terms of innovation and technology, most are passive adopters. Investing in ICT-enabled solutions improves the general understanding of information systems, IS success issues and IS implementation overall. In order to overcome the challenges of lack of knowledgeable personnel, lack of top management support and the ever changing requirements, it is important to use Decision Enhancement Services to enhance the IS assessment process.

Based on this reasoning, we formulated the research objective as follows: "*To develop an approach to improve the prospects of IS success in developing countries*". To meet this

objective, we developed four research questions as follows:

- *What theories can be used to explain IS success?*
- *How should a solution for ensuring IS success in developing countries look like?*
- *How can we develop a solution for ensuring IS success in developing countries?*
- *How can we evaluate the solution to provide support to IS managers in developing countries to ensure IS success?*

In this research, we focused on the utility of a studio to facilitate and improve assessment of information systems.

Research Methodology

This research applied an inductive-hypothetical strategy that is suitable to study, support theory building and evaluate a studio to facilitate enhancement of information systems assessment. This strategy consists of the phases: initiation, abstraction, theory building, implementation and evaluation. Knowledge about IS implementation and success issues was obtained using an exploratory study. The exploratory study enabled us to get a better understanding of the IS success issues to be considered. We also carried out a literature review to get an overview of the theories that guide the IS assessment process. We evaluated the studio based on the usefulness, usability and usage using a case study setting in three organizations that have large IS in Uganda.

An exploratory case study was carried out in the four regions of Uganda represented by Kampala, Gulu in the north, Kasese and Mbarara in the west and Soroti in the east. The study enabled us understand the main issues in assessing information systems in a developing country context and how ICT could be used to improve IS assessment in developing countries. The case study revealed that the development of such a solution is complex due to the complex, interdependent and multi-dimensional nature of IS success as well as the diverse nature of the stakeholders in IS. Most of the organizations suffered from lack of knowledgeable personnel, internal politics, a rigid management style and complicated financial assessment methods.

A literature review was conducted to identify a number of initial theories that could be applied to the problem under investigation that is assessment of information systems in developing countries. We learnt that the theories that are used to provide solutions in the

developed world were not all appropriate for use in a developing country context. This was because the majority were complex, and those that were not, were not taking into account all the factors that are found in a developing country context. In addition, they do not provide an integration of technology, people and process to enhance assessment of information systems. Decision enhancement services fuse technology, people and process in an interactive environment to enhance assessment of information systems in developing countries.The concept of decision enhancement services provides a solution that facilitates a balanced integral approach for assessment of information systems in developing countries. Additionally, the literature review showed that IS assessment is complex, multi-faceted and involves diverse stakeholders who have different goals and objectives in the design process. From the IS assessment theories discussed, none was geared towards problem solving.

IS Assessment Instrument

We applied the "four ways of" framework: way of thinking, way of controlling, way of working and way of modeling to articulate an IS assessment studio design (Sol, 1988). Decision Enhancement Services facilitate the IS assessment as the way of thinking. IS assessment decision enhancement services are composed of people, technology and process. The way of controlling describes measures and methods for using the IS assessment instrument. The way of working specifies the steps that are followed in carrying out IS assessment. The activities involved include training on the instrument and IS issues; communicating simulation results with other stakeholders by posting results on the Web and assessing information systems of their choice. The guidelines specify how each activity is followed to its logical conclusion. The way of modeling identified the modeling tasks and the use of modeling concepts that are suitable for modeling relevant aspects of the problem situation. We adopted System Dynamics to construct the models that were used to implement the IS assessment instrument (ISASSI) as a suite within a studio. The three modes that are employed in the studio are described below:

1. **Training Mode**: The learner, under the guidance of a skilled user uses the graph and pad provided in the training mode to set up experiments by selecting from the available input and output variables. She is able to observe the outputs as well as corresponding changes in the input over time. The quantitative output given by the table re-enforces the visual output from the graph giving deeper insight to the learner. The training mode facilitated stakeholders in apparaising themselves of IS success issues, on how the instrument works and provided a common understanding for all participants.

2. **Communication Mode**: The communication mode enables stakeholders to communicate the results of their experiments on a particular IS, by publishing them over the Web. Since the instrument is flexible, the stakeholders could communicate information about current performance, using information from users or past performance using information from reports. The communication mode was instrumental in sharing information about the assessed IS and insights gained.

3. **Assessment Mode**: The assessment mode enables stakeholders to come together, discuss an IS of their choice and using knowledge of this IS, set the values for the variables to be used in simulation experiments to help in assessment of that particular IS. The results of the discussions are recorded thus gaps in knowledge are filled and practitioners share a common understanding. The assessment mode facilitated participants in generating debate about their IS and assessing the given IS leading to greater insights.

We carried out an evaluation of the IS assessment instrument and its supporting guidelines on how to use it using questionnaires with reflection on the studio. The studio was tested on the three U's (Keen and Sol, 2008) in a case study setting. The participants were satisfied with the studio approach in the assessment of information systems. The participants were confident with the usefulness, usability and usage of the studio. Overall, the studio was presented to determine the value it adds to IS assessment in developing countries. Various insights were derived from the testing of the studio:

- The availability of training helped all participants achieve a common understanding of IS issues and their IS.
- The availability of guidelines helped the participants to easily understand the instrument and enabled them to assess an IS of their choice.
- Going through the process of preparing for assessment and discussing the information systems openly helps practitioners visualize bottlenecks they were not focusing on before.
- Recording of outcomes of discussions on a round-table basis means that gaps in knowledge are filled in and practitioners share a common understanding.
- With the requirement for the participants to feed data into the instrument themselves before running simulation experiments, they were able to discuss freely the

challenges they faced, leading to greater insights than they had imagined.

- The simplicity and understandability of the instrument made it easy for the users to interact with it.
- The ISASSI instrument improves the support provided for assessing IS.

Conclusions and Recommendations

Based on the research, we conclude that the ISASSI instrument is useful and usable in facilitating IS assessment in developing countries. The instrument provides training on IS issues, communication of results and assessing a chosen IS. By developing and evaluating the ISASSI instrument in Uganda, we achieved the objectives of this study. Specific areas we recommend for future research are 1. To further address generalizability issues, the ISASSI may be implemented in other developing countries. 2. Results show that the ISASSI works well in large organizations. Therefore, further research in its applicability in SMEs is recommended. 3. One of the issues that arise during the maintenance period of the information system is the cost of maintenance. It is recommended to incorporate a costing tool for determining whether it is still cost-effective to keep the IS.

Samenvatting (Dutch Summary)

Introductie

Recent onderzoeklaat zien dat 20 tot 30 procent van informatiesystemen (IS) beschouwd worden als mislukt. Deze situatie is nog erger in ontwikkelingslanden, waar het gebrek aan goed opgeleid personeel hoog is. De mislukkingen in ontwikkelingslanden worden toegewezen aan een aantal factoren, zoals een gebrek aan ondersteuning vanuit het management, veelvuldige wijzigingen van de gestelde ontwerpeisen, slechte infrastructuur, politieke instabiliteit, wisselend personeel en een gebrek aan voldoende bronnen om een IS in stand te houden. Het implementeren van een succesvol informatiesysteem is erg belangrijk voor ontwikkelingslanden omdat een slechte implementatie van informatiesystemen een negatieve economische impact heeft. De meeste oplossingen die beschikbaar zijn, komen uit ontwikkelde landen, maar zijn niet direct toepasbaar in ontwikkelingslanden omdat de context waarin IS worden gebruikt verschillend zijn.Zulke oplossingen hebben behoorlijke aanpassingen nodig om te voldoen aan de specifieke gebruikerswensen in ontwikkelingslanden.

Literatuurstudies suggereren dat ICT een oplossing kan bieden voor enkele van de problemen die in ontwikkelingslanden spelen, en dat het gebruik van ICT de implementatie van IS in ontwikkelingsgebieden kan vergroten.Hiervoor zijn valide argumenten temeer daar de context van ontwikkelingslanden wordt gekarakteriseerd door adoptie van technologien die vaak onbruikbaar. Ontwikkelingslanden hebben vaak te maken met grote schulden en in termen van innovatie en technologie zijn de meeste gebruikers passief. Investeren in door ICT mogelijk gemaakte oplossingen verbetert het algemene begrip van informatiesystemen, leidt tot IS succesverhalen en biedt betere IS implementaties. Om de uitdaging aan te kunnen van een gebrek aan personeel met de juiste kennis, het gebrek aan managementondersteuning en de steeds wisselende benodigdheden is het belangrijk om het IS ontwerpproces beter te kunnen beoordelen.

Vanuit deze redenering hebben we het doel van het onderzoek als volgt geformuleerd: om

ondersteuning te bieden bij duurzaam werkende informatiesystemen in ontwikkelingslanden. Om dit doel te bereiken hebben we 4 onderzoeksvragen geformuleerd t.w.:
- Welke theorien kunnen worden gebruikt om het succes van IS te verklaren?
- Hoe moet een oplossing voor langdurig IS succes in ontwikkelingslanden eruitzien?
- Hoe kunnen we deze ondersteuning realiseren?
- Hoe kunnen we de oplossing evalueren?

In dit onderzoek hebben we de nadruk gelegd op het gebruik van een studio om vooruitgang te boeken bij de beoordeling van informatiesystemen.

Onderzoeksaanpak

Dit onderzoek gebruikte een inductief-hypothetische strategie die bestaat uit de volgende fases: initiren, conceptualiseren, theorieopbouw, uitvoering en evaluatie. Kennis van IS uitvoering en van succesfactoren werd verkregen door een verkennende studie. Deze studie gaf ons de gelegenheid om beter te begrijpen welke factorenin aanmerking kwamen.
We hebbenvervolgens een literatuurstudie uitgevoerd naar de theorien op dit terrein. Het door ons ontworpen instrument, een studio voor IS beoordeling, is gevalueerd op bruikbaarheid, gebruiksvriendelijkheid en gebruik aan de hand van toepassing in 3 organisaties met grote IS in Oeganda.

De verkennende studie werd uitgevoerd in vier regios van Oeganda gerepresenteerd door Kampala, Gulu in het Noorden, Kasese en Mbarara in het Westen en Soroti in het Oosten. De studie gaf ons zicht op de belangrijkste aspecten bij het beoordelen van informatiesystemen in ontwikkelingslanden. Het onderzoek liet zien dat de ontwikkeling van een mogelijke oplossing complex is vanwege de complexiteit, samenhang en multidimensionale aard van IS succes alsmede de diversiteit van belanghebbenden in IS. De meeste organisaties hebben een gebrek aan kundig personeel, een negatieve interne politiek, een rigide managementstijl en gecompliceerde financile beoordelingsmethoden.

Een literatuurstudie werd uitgevoerd om een aantal initile theorien te identificeren om het succes van informatiesystemen in ontwikkelingslanden te beoordelen. We leerden dat theorien over succes van IS in ontwikkelde landen geen rekening hielden met specifieke factoren die een rol spelen in de context van onderontwikkelde landen. Daarnaast besteden ze geen aandacht aan de integratie van technologie, personen en processen.DecisionEnhancement Services (DES) brengt technologie, personen en processen samen in een interactieve omgeving om beoordeling van informatiesystemen te ondersteunen. Aanvullend geeft

het literatuuroverzicht aan dat IS beoordeling complex en multidisciplinair is en diverse belanghebbenden bij elkaar brengt die verschillende doelstellingen in het ontwerpproces hebben. Van alle besprokentheorien was geen gericht op probleemoplossing.

IS beoordelingsinstrument (ISASSI)

We hanteerden het 4-wijzen raamwerk: de wijze van denken, de wijze van controleren, de wijze van werken en de wijze van modelleren om een studio voor de beoordelingvan IS te beschrijven Decision Enhancement Services faciliteren de IS beoordeling als manier van denken.
De manier van werken specificeert de stappen die worden gevolgd om IS beoordelingen uit te voeren. Aandacht wordt besteed aan training van ISASSI en het communiceren van simulatieresultaten met andere belanghebbenden. De richtlijnen specificeren hoe elke activiteit gevolgd wordt door een logische conclusie.
De manier van modelleren identificeert de stappen en concepten om relevante aspecten van eenIS probleemsituatie te beschrijven. We hebben System Dynamics gebruikt om de modellen te construeren en het IS beoordeling instrument (ISASSI) te implementeren als een suite binnen een studio.
De studio kan in 3 modi gehanteerdworden:

1.Trainingsmodus: de student, onder leiding van een gekwalificeerde gebruiker gebruikt ISASSI om experimenten uit te voeren d.m.v. selectie van enkele variabelen. Zij is in staat de uitkomsten te observeren zowel als de overeenkomstige veranderingengedurende een bepaalde periode. De trainingsmodusdraagt bij aan het begrip bij belanghebbenden van IS succesfactoren, hoe het instrument werkt en biedt een gemeenschappelijke begripsbasis aan alle deelnemers.

2.Communicatiemodus: belanghebbenden communiceren resultaten van hun experimenten met een specifiek IS systeem via het Web.Het instrument is zo flexibel dat de belanghebbenden informatie over de huidige prestaties kunnen delen, uitgaande van vorige analyses en rapportages.

3.Beoordelingsmodus: belanghebbenden komen samen om een IS te bespreken, ensimulatiexperimentenop te stellen. De resultaten van de discussies worden vastgelegd en gedeeld. Dit leidt tot groter inzicht.

We hebben het IS beoordelingsinstrument geevalueerdop de 3 Us in verschillende casussen. De gebruikers waren positief over de aanpak en het geboden instrument. Zij hadden vertrouwen in de bruikbaarheid, gebruiksvriendelijkheid en gebruik van het instrument. Verschillende inzichten kwamen voort uit testen van het instrument:

- De beschikbaarheid van training droeg bij aan een gezamenlijk begrip bij deelnemersvan hun IS en de belangrijkste aandachtspunten.
- Richtlijnen hielpen deelnemers om het instrument sneller te begrijpen en een IS naar keuze te beoordelen.

- Door het instrument te gebruiken konden deelnemers knelpunten visualiseren die voordien niet waren voorzien.

- Het vastleggen van de uitkomsten van rondetafeldiscussiesvulde leemtes in kennis bij deelnemers op.

- De eis voor de deelnemers om zelf data in het instrument in te geven om een simulatiexperiment aan te gaan, gaf ze de gelegenheid om vrijuit te discussieren over de uitdagingen die ze tegenkwamen,hetgeen tot meer begrip leidde dan ze hadden verwacht.

- Eenvoud en begrijpelijkheid vereenvoudigt de interactie met het ISASSI instrument.

- Het ISASSI instrument vergroot de ondersteuning voor de beoordelingdeling van IS.

Conclusies en aanbevelingen

Op basis van dit onderzoek concluderen we dat het ISASSI instrument bruikbaar en toepasbaar is om IS beoordeling in onderontwikkelde landen te faciliteren. Het instrument biedt mogelijkheden voor training, communicatie en beoordeling van een gekozen IS. Door een ISASSI instrument voor Oeganda te ontwerpen en evalueren hebben we het doel van dit onderzoek bereikt. Onderwerpen die we aanbevelen voor toekomstig onderzoek zijn:
1.De generaliseerbaarheid vanhetISASSI instrument in andere onderontwikkelde landen.
2.De inzetbaarheid van ISASSI in grote bedrijven is positief.Onderzoek naar de toepassing

bijSMEsis aanbevolen.

3.De kosten van het onderhoud van informatiesystemen kan worden meegenomen in ISASSI ter beoordeling van rendementen.

Curriculum Vitae

Paul Ssemaluulu (Buyege, 1957) obtained his FTC in Telecommunications from Kyambogo Polytechnic in the year 1985 while working for Uganda Posts and Telecommunications as a Senior Technical Officer. He joined Philips International Training Center (PITTC) in The Netherlands in 1987, where he trained in Telecommunications and Computing. In 1989, he studied digital switching at DTC in The Netherlands and became a digital switching specialist for the 5ESS-PRX. He trained with Fujitsu on Fiber-optic cable and transmission equipment in Nakahara-Ku, Japan in 1991 and later trained as a professional Telecom Manager with Nepostel in The Netherlands in 1995. Ssemaluulu worked as Telecom Manager from 1993 to 2001 in UTL. He obtained his degree in Business Administration in 2002 from Makerere University. He worked briefly in Makerere University Business School, before joining Kyambogo University where he worked as Assistant Lecturer in IT and Programmer in the PTC Section. From here he went on to obtain his Masters in Computer Science (Distinction), majoring in MIS in 2006, Makerere University. At the time, he was already teaching at the Faculty of Computing and Informatics Technology, Makerere University from 2004. He was lucky to be recommended for sponsorship to study in The Netherlands in 2009 at Groningen University under the NUFFIC II project.